THE

ELECTRICAL REVIEW.

VOL. LV. DECEMBER 16, 1904. No. 1,412.

ELECTRICAL REVIEW.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1905 Edition

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COMPETITION AND PROTECTION.

THE British Westinghouse Electric and Manufacturing Co. appears to be as freely advertised in adversity as in those preliminary stages, when its phenomenal progress in bricklaying was periodically referred to as an indication of what might be expected when the roof was on, the machinery installed, and the process of manufacture commenced. But the proceedings of the company are of more public interest now than on those earlier occasions, though the daily Press could then always find room for descriptions of the "hustling" methods whereby the vast works would be completed at the earliest possible moment, and the "hustle" transferred to the manufactures which were to fill those works, even if all others were depleted.

In our last week's issue we gave a full report of the proceedings at the company's meeting, and it will have been noticed that the deputy chairman, who presided, dealt with the question of the extensive nature of the works as something relating to others. He expressed no opinion himself, but remarked that "the company was evidently not formed, nor the works built, for the present, or for the next two or five years, but upon what must have been a conscious belief on the part of those who initiated the undertaking, and who still believed in the correctness of their view, that it would not be found too large for the work that would one day come to it—be that day far or near."

Reading between the lines of this statement, it is not difficult to observe some sort of "conscious belief" on the part of Mr. Buchanan, that he would have had an easier task before him if the distant future had been provided for on the plans—which cost little, and do not depreciate—rather than by bricks and mortar, machinery and equipment, which cost a great deal, and may have to bear considerable depreciation by the time they are brought into remunerative operation. We can imagine the deputy chairman inspecting the Press cuttings relating to the earlier stages of the company's career, and expressing some regret that the bricks had been laid quite so fast or quite so freely. But leaving the past, and coming to the present, we can express our agreement with his further statement, that "results secured during the early years of the life of any large industrial enterprise were not conclusive as to what its future would be." As we remarked in the previous week's issue, it was a mistake to expect immediate returns from such an investment, and it will, no doubt, now be recognised that it was a mistake to pay the earlier dividends, although it may be presumed that the payment of dividends was somewhat intimately related to the provision of further capital. The shareholders, of course, deplore the absence of dividends, and one of them at the meeting informed the deputy chairman that "they might be willing to let bygones be bygones, if he would only give them some assurance as to the return they would get this year." Mr. Buchanan's refusal to indulge in the ex-

pression of any vain hopes or smooth words is, to our minds, one of the most promising features of the situation. His remarks, so far as they relate to the affairs of the company, inspire confidence. It is only when he deals with greater questions that it becomes necessary to express the hope that the company's business may not be dependent upon the changes that the managing director would like to see in our fiscal policy.

It would seem that no meeting of an electrical company is now complete without a reference in the chairman's speech to competition and protection. Mr. Buchanan follows the general example, but whilst the tendency of his remarks will undoubtedly be considered to place him on the side of protection, free traders will find no occasion to be alarmed at them. For his own view of competition from sources outside Great Britain, is that the deleterious effect is not so much the amount of business contracted, but rather the influence the presence of this competition in all important tenders exerted upon prices quoted by British manufacturers, because it became necessary to try in advance to discount this unknown outside price, the result being that much lower prices were made than would be the case were the competition limited to Great Britain alone. In these remarks may be traced that inability to comprehend the nature of business in a "free market" which might be expected from one of Mr. Buchanan's experience. To close the market to foreign manufactures is one stage; to have no "unknown prices" to quote against is the next. Efforts in the latter direction are either talked of or in operation in various branches of electrical, as of other, manufactures. For their full success, they need, of course, the protection against imports which the British Westinghouse Co. and some others now desire. Let us compare these remarks of Mr. Buchanan with those of another chairman. Mr. J. W. Barclay, addressing the shareholders of the Electric Construction Co. (Electrical Review, July 22nd, 1904), gave some information regarding the keen competition prevailing. "He would, however, tell them that it was not foreign competition that had brought prices down to their present level, for they were now lower than any prices of Continental or American manufacturers quoted in this country. Within the last few years new factories had been established both in England and in Scotland, and although he looked for a large development in the use of electric power, they must expect and be prepared for keen competition for some time . . . . There must be a time of stress, but the fittest would survive, and he would only add that they meant to be of the number." Is it possible that, amongst those new English factories referred to by Mr. Barclay as contributing to the keenness of competition, the British Westinghouse Co. was itself included? Perhaps, in its laudable anxiety to to fill its shops with work, the company has reduced prices below a paying level, to its own disadvantage and to the disadvantage of its competitors, who in their turn are compelled to "try in advance to discount the unknown price," not of foreign manufacturers, but of this British organisation.

It is well to recognise the keenness of competition which has been prevalent, but it is not well to rely upon unhealthy methods of overcoming the consequences of such competition. The worst thing which could happen to the electrical industry would be protection, or reliance on trade combinations which have for their aim in one form or another the abolition of that freedom between buyer and seller, that "free market" upon which our prosperity has been built and maintained. In what directions are we looking as most promising for early work but to the transformation of existing systems of traction, or to the provision of alternative supplies of power? If that work does not come at a time when manufacturers complain that prices leave no profit, are we to expect it to come when those prices are inflated by protection or combination? Obviously not.

The explanation of the keenness of competition must be sought for in the fact that manufacturers have prepared for work somewhat in advance of its coming. Some have prepared wisely and in moderation. Others—amongst whom we are afraid we must include the British Westinghouse Co. —have prepared immoderately when the immediate future is considered. And the affairs of this particular company seem to suggest the further important question of how far production on an abnormally large scale is economical, when the maintenance of the plant and the organisation in periods of depression are taken into account. This depression in the past few years is simply due to the fact that money has not been available in suffi ient quantity for all the transformations or new enterprises which those who are acquainted with the advantages and economy of electrical methods know, are ripe for commencement. Capital is required, and capital in time will be forthcoming. Meanwhile there is "a time of stress," and to outlive that time of stress will require a sound constitution and a careful husbanding of resources. Only the weak will call for protection, and if they ever got it they would be the first to suffer.

Electrical Trades Benevolent Fund.

The letter which we publish to-day, from Mr. Justus Eck, should appeal with confidence for the support of all our readers. At present the only funds of this nature available for electrical men are that of the Institution of Electrical Engineers, and that of the British Electrical Friendly Society. The former, we believe, is confined to the relief of members of the Institution, and is rarely—if ever—drawn upon. The latter, founded by the British Electric Traction Co. at the suggestion of Mr. E. Garcke, but open to electrical men outside the companies with which he is associated, is in a flourishing condition, and has done excellent work. We believe that the fund which it is now proposed to establish is not intended in any way to rival either of these funds, but rather to supplement them and to reach all classes of men employed in, or in connection with, the electrical industry. Possibly the different funds may eventually be amalgamated. We are not acquainted with the details of the scheme, but we cordially commend the movement to the sympathetic consideration of our readers.

Electric Railway Traction.

The subject of electric traction on railways is very much to the fore in our pages to-day; we give some particulars of the single-phase work on the Spindlersfeld Railway, an account of the first semi-public trip on the newly equipped electrical section of the Metropolitan Railway, and an abstract of an interesting paper by Mr. F. W. Carter, in which, on the strength of such data as are available, the author discusses the important question whether high speed main line trains will be propelled by motor-cars or hauled by locomotives—giving his verdict in favour of the latter, in opposition to generally accepted ideas. This question is of a controversial character, and we anticipate that the supporters of the motor-car system will not be slow to take up arms in its defence.

THE SPINDLERSFELD SINGLE-PHASE ELECTRIC RAILWAY.

Although every indication points to a more or less universal adoption of overhead conductors for heavy electric traction in the near future, the step is more of a reversion to former practice than anything new, and this particularly applies to the case of the Spindlersfeld line, because not only is the use of an overhead conductor a revival of early experiments, but the very method of suspension adopted is a modified revival of the construction employed on the lines between Offenbach and Frankfort, and between Vevy and Montreux, in the very earliest days of electric traction. In the case of the two lines just mentioned, the current was collected from an overhead conductor in the shape of a split copper tube, suspended from a longitudinal suspension or bridle wire immediately above it. The sliding contact took the form of a shuttle sliding along inside the copper pipe, the car to which the shuttle was attached pulling the latter along.

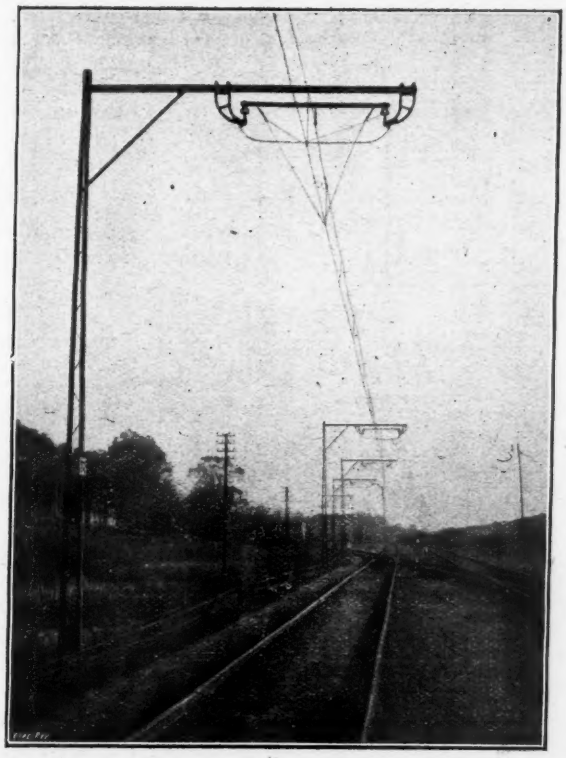


Fig. 1.—Single Bracket Single-Wire Suspension.

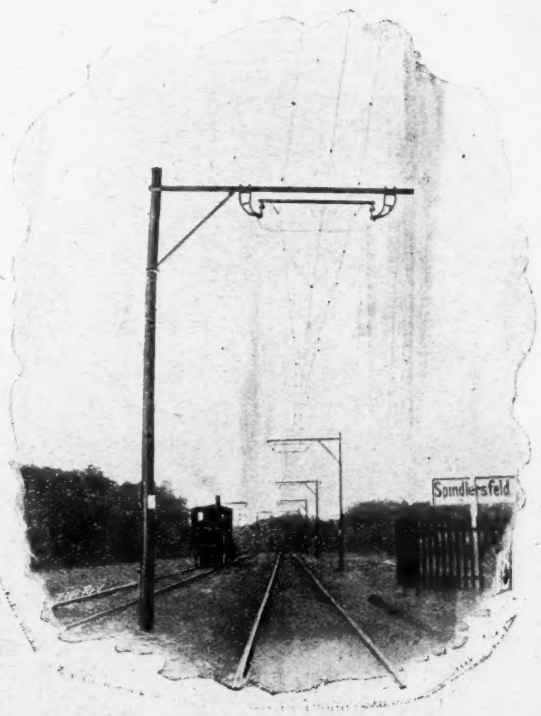


Fig. 2.—Single Bracket Double-Suspension Wire Construction.

Overhead conductors were originally employed on the Baltimore and Ohio tunnel line under the city of Baltimore, and were only abandoned in favour of the third rail on account of the large current which had to be collected, owing to the very limited voltage imposed by the use of the direct current system. With very few exceptions there are many disadvantages to be urged against the use of a charged conductor situated on or near the ground, and in many situations it would be quite impracticable to install such a system. Especially is this the case when we have to consider the possibility of adopting electric traction on some of the suburban steam railways running into London or other large cities. The difficulties of laying down and maintaining a third rail in such situations have led most engineers to the conclusion that the overhead system is the only one which is at all feasible. The question of single phase *versus* direct current traction has already been treated in these columns, and we do not intend to re-open the discussion at the present moment, but the method of construction used at Spindlersfeld is interesting, if for no other reason than as evidence that it is quite possible to employ an overhead conductor charged at very high pressure, without in the least endangering the safety of passengers or those employed upon the line. We do not suggest that the Spindlersfeld line represents the ideal state of affairs, but the main principle is quite sound, and could, with more or less slight modification, be employed with complete satisfaction in this country.

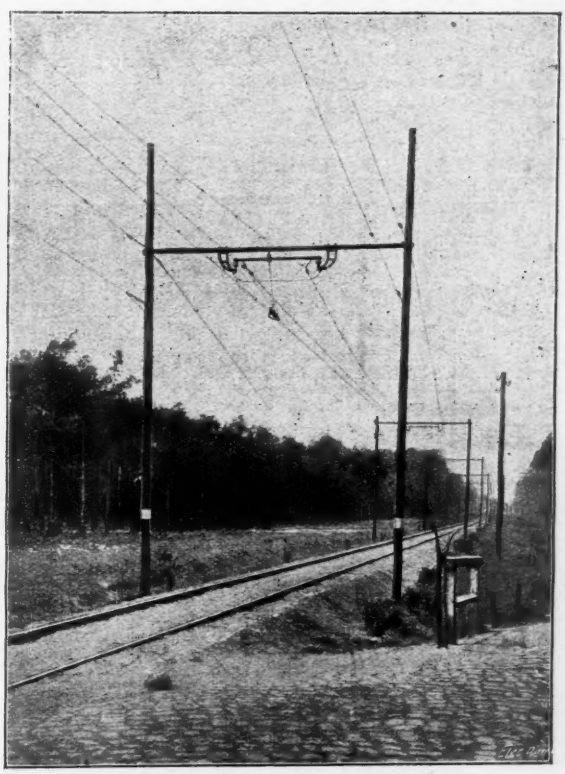


Fig. 3.—Double-Pole Double-Suspension Wire Construction.

As already mentioned, the conductors are supported from longitudinal suspension wires, either one or two such wires being employed for each conductor; both methods are in use on this line. Single wires were originally employed,

the double bridle wire construction being a more recent experiment to obtain greater safety, and also increased stability of the conductor. In view of the high pressures which are an inherent part of the single-phase system, there is much to recommend the use of double suspension, since with this method there is practically no chance whatever of any charged metal falling to the ground.

Fig. 1 shows a view of the portion of the line upon which single suspension has been installed. The illustration shows the line suspended from side bracket arms, but side poles and span wires can be used if desired. This also applies to the construction employing double bridle wires, which is illustrated in figs. 2, 3 and 4. An examination of fig. 4 in conjunction with the following description will explain the method employed to support the wire freely, and yet provide for any breakage which may occur in any portion of the material.

The trolley wire or conductor itself is connected to the bridle wires by short lengths of wire, the length of these being adjusted to give what is practically a horizontal conductor without appreciable sag. The bridle wires are supported by short lengths of rubber chain, from a bar which is mounted upon two insulators attached to the bracket arm by means of suitable clamps. Underneath the bridle wire there is an earthed bar, so that in the event of either of the suspension wires falling from its support, it comes in contact with the earthed bar, and produces a short circuit which immediately throws out the circuit-breaker protecting the line. The bar is connected to the metal pole, which in turn is connected metallically to the rails.

As already mentioned, the double suspension has the great advantage of giving a considerable amount of lateral rigidity to the aerial conductor, and it likewise provides a very large factor of safety, for, even in the event of the failure of one of the suspension wires, the trolley wire would not fall to the ground, for both it and the broken wire would be held up by the other sound one. A short study of the details of the arrangement will show that it is a practical impossibility for any charged wire to reach the ground, even in the event of a considerable number of wires breaking. The trolley wire and the bridle wires are linked together at such short intervals that, even if both the latter were to fail at the same time—which is a very remote contingency—the former wire would be strong enough to prevent a complete collapse of the whole structure, though the sag caused by the fracture would be sufficient to earth that portion of the line, and so render it harmless through the operation of the circuit-breaker.

The method of construction involves a certain complexity of wires, which suggests that snowstorms might have to be taken into account in designing such a system for this country. In the event of a heavy fall of snow, there is no doubt that the construction would be somewhat severely stressed by the additional weight of the snow which would be liable to collect at the junctions of the various wires. But, except in countries where very heavy falls of snow are common, there does not seem to be any reason to suppose that this difficulty could not be successfully surmounted by making the wires sufficiently strong to bear the additional weight.

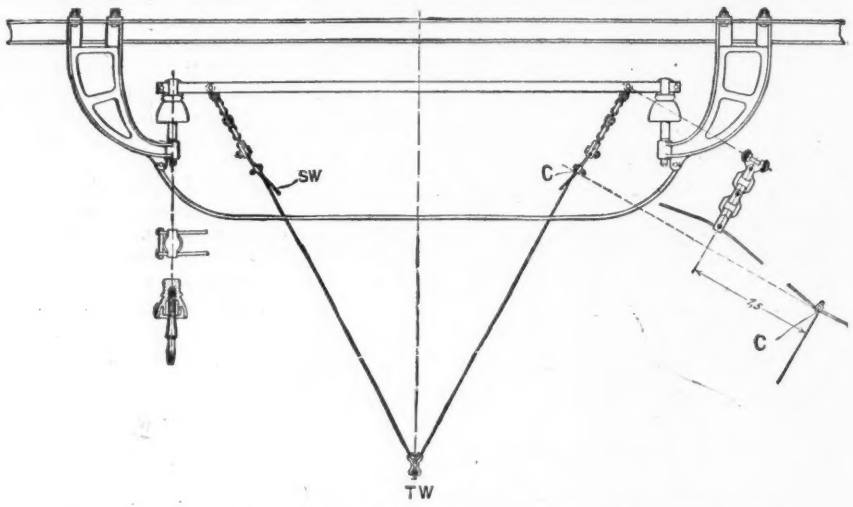


Fig. 4.—Double Suspension.—TW, Trolley wire; C, Clamp; SW, Suspension wire.

At curves a special arrangement, illustrated in fig. 5, is used. From this it will be seen that struts are introduced between the trolley wire and the bridle wire or wires on the inside of the curve. To the lower end of each strut is pivoted a short bent lever, of which the lower end is attached to the conductor wire, while the other end is stayed by a short wire to the suspension wire on the outer side of the curve. A construction somewhat similar to this is always adopted on tramways wherever the Siemens bow trolley is in use.

Telegraph, telephone and other wires passing over the trolley line, are protected by a wire cage, which completely surrounds them, and prevents any possibility of their coming in contact with any of the high tension material (see fig. 6).

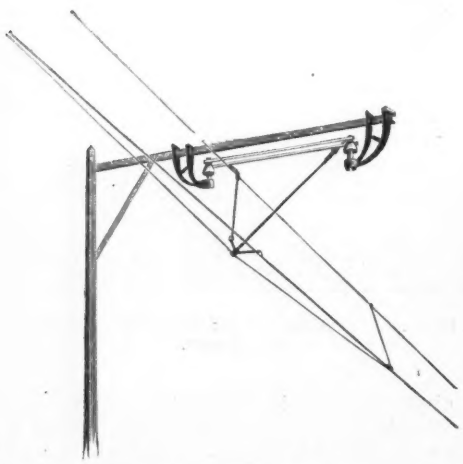


Fig. 5.—Method of Supporting Wire at Curves.

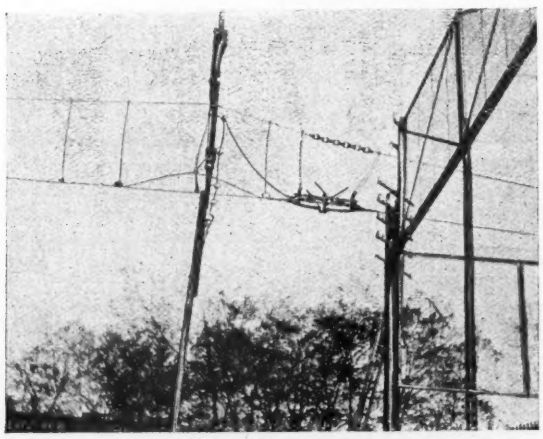


Fig. 6.—Metal Cage carrying Low Tension Wires over Trolley Line.

The type of section insulator used on ordinary tramways would, of course, be quite useless for such a line as this, and insulators specially constructed to deal with the high pressures have to be employed. A continuous running surface for the bow is provided by a porcelain connecting piece, and any arc which may be formed is blown out by "horns" similar to those commonly employed in horn lightning

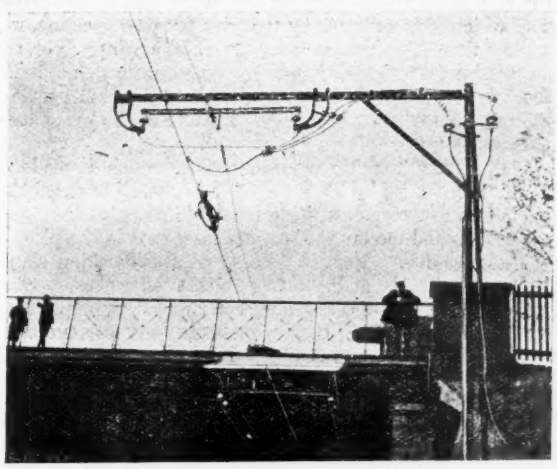


Fig. 7.—Section Insulator in Position.

arresters. These section insulators are provided with two switches, by which the line can be connected through, if desired, the switches being operated from below by means of an insulated cord. The arc formed on breaking the circuit is blown out by the horns mentioned above. Figs. 7 and 8

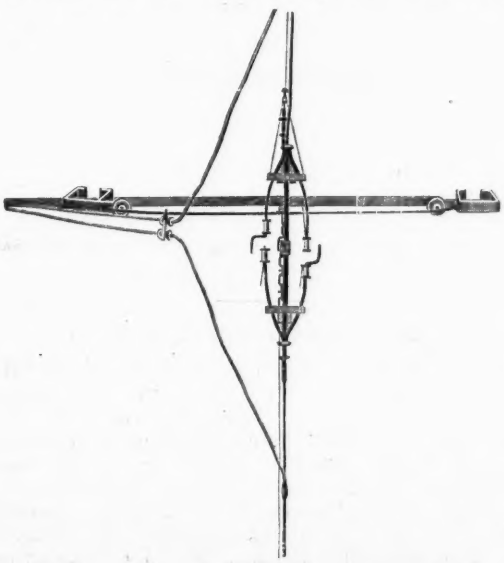


Fig. 8.—View of Section Insulator, from Below.

show the general construction of the insulator and switches, and the method of feeding the line, which does not differ materially from that employed on most tramway systems.

(*To be concluded.*)

THE CONICAL WIND MOTOR.

By DR. ALFRED GRADENWITZ.

The Danish Government has for a number of years paid much attention to the problem of utilising the power of wind, and Prof. La Cour has been entrusted with the conduct of systematic experiments in that direction in an experimental mill built expressly for the purpose, in the neighbourhood of the town of Askov. Now, some years ago, Mr. Sörensen, a mill engineer, submitted to the Danish professor a wooden wind motor of his own construction, which had shown quite a surprising performance, as, four of the 10 sails of the motor having been broken by a storm, the mill, far from being damaged, worked more satisfactorily than before. This fact showed that the ancient principle, according to which the amount of power gained would be the higher the greater the surface, was false, and further experiments by Prof. La Cour go to bear out this conclusion.

Mr. Sörensen, with the aid of the experience thus gained improved his motor, and eventually supplied the experimental mill with some wind motor models of a conical shape, having six wings with their points bent forward, the surface area, inclination of wing points and inclination of the wheel shaft being determined according to certain principles. Two types were subsequently tested jointly with eight other wind motors of all the current patterns, including motors with wings both narrow and broad, hollow and level, more or less numerous, and of varying inclination, but all of which had the same diameter as the conical wind motors. The results of some of these comparative tests are shown below, and the shapes of some of the motors are also indicated :—

	Fig. 1. Ventotrat.	Fig. 2. Wind-rose.	Fig. 3. Sörensen's old motor.	Fig. 4. Conical wind motor.
Ares, sq. cm.... ...	7,440	2,976	1,116	1,188
Ou put, kgm. sec.	1·59	1·77	1 81	2·34

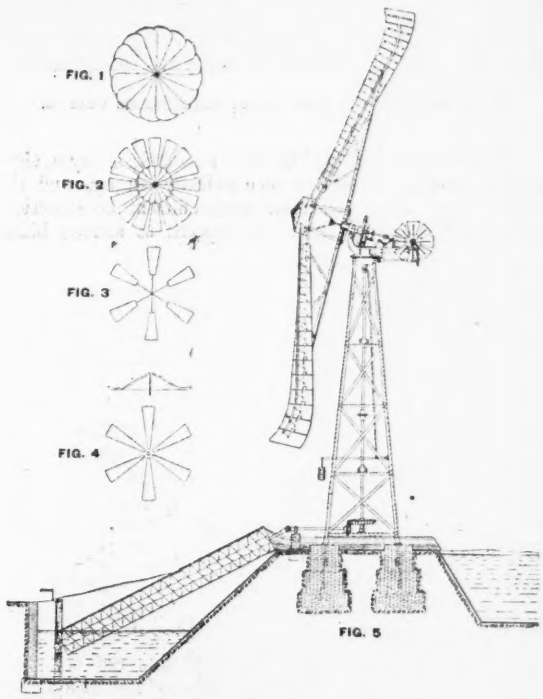


Fig. 5.—Waterworks with 15-h.p. Conical Wind Motor.

It is hence inferred that conical wind motors will give an output nearly 50 per cent. higher than a ventotrat, which is seven times greater, 33⅓ per cent. higher than a wind-rose of 2·8 times greater surface, and 29 per cent. higher than the original Sörensen motor, which was only 7 per cent. smaller.

This extraordinary power of conical wind motors may thus be accounted for :—The main force of the wind will be applied to the paddle-shaped extremities, the parts most effective in producing torque ; while, on the other hand, the wind will be allowed to pass between the wings, thus carrying along the air behind the latter and reducing the back pressure.

That the wind acts on a perforated surface with a power much greater than in the case of an equal surface closed throughout, is borne out by the following experiment :—Two plank fences of the same thickness and height, one of which had intervals between the planks, while the other was compact, were submitted to the action of the wind, when the open fence was thrown down, though the compact fence

obviously opposed the greater surface to the wind. A further fact known in this connection is that perforated sails will work more satisfactorily than those free from any holes, and this has been utilised in a recent Italian invention.

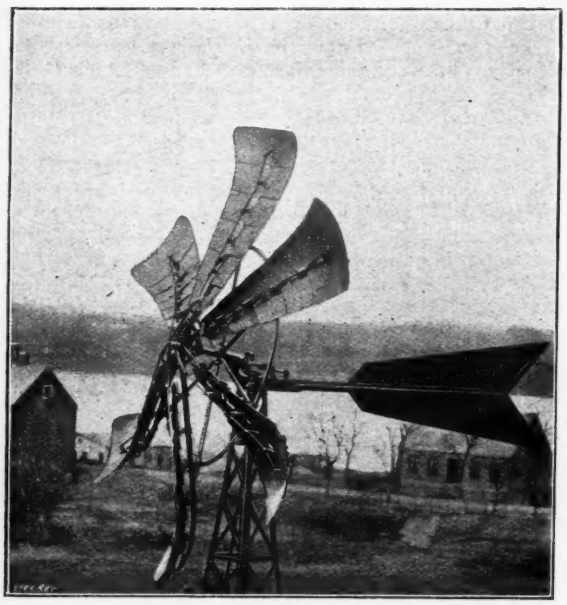


Fig. 6.—Conical Wind Motor, with Wings Closed.

A further feature of conical motors is their safety against storms. Conical forms are mechanically strong, and the conical shape allows of a far more efficient construction, mechanically; moreover, the area exposed to sudden blasts

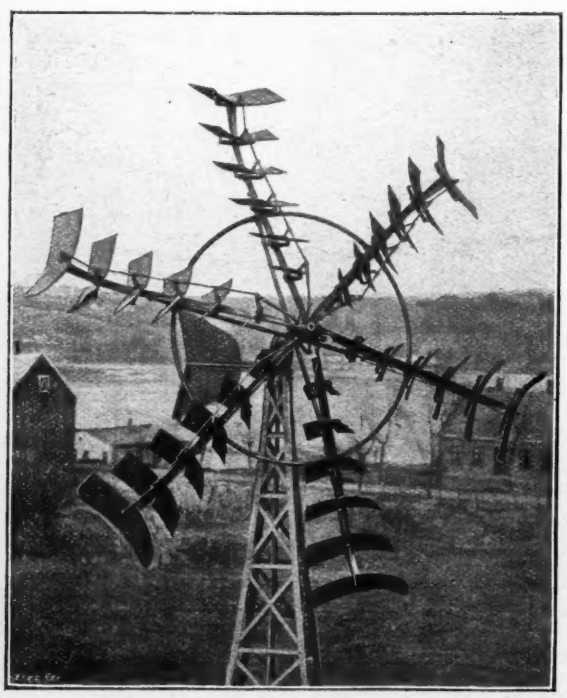


Fig. 7.—Conical Wind Motor, with Wings Open.

is quite immaterial in the case of conical wind motors. In the state of rest, the motor is left with the sections wholly opened, as in fig. 7.

Another feature, *i.e.*, the automatic regulation of the motor, will prove of the highest importance. This regulation is effected by the swivelling boards of the wings being opened by their centrifugal force, when the speed of rotation exceeds a prearranged amount, thus allowing the surplus wind to pass through. As soon as the wind slackens down, the motor rotates at a slower rate, the centrifugal force of the boards will no longer keep them open, and a counter-weight draws them together automatically. The regulation according to the direction of the wind, *i.e.*, the steering of the motor, also takes place automatically. In smaller types (up to 6 H.P.) this is done wholly by means of a weather flag, which, being thrown by the wind into its direction, will at any time turn the motor towards the wind. For the larger types of motor a wind-rose is used instead, adjusting the wing wheel to the wind by means of worm gearing. Motors intermediate between 6 and 15 H.P. may be fitted either with a flag or with a wind-rose.

Apart from the above steering flag, which is made of wood, the conical wind motor consists wholly of iron and steel, even the wind-rose being made of iron.

Conical wind motors are in many cases used in the place of a steam engine. Pumps, wood and iron-working shops, and agricultural and milling plants may be operated by these wind motors, which do not require any appreciable amount of supervision; they may also be used for generating electricity. For the latter purpose, the firm of Theodor Reuter & Schumann, of Kiel, Germany, who are the manufacturers of the motors, have designed a very simple apparatus for regulating the speed of the gearing driven from the wind motor with absolute accuracy, as required by a dynamo. Another device enables a wind motor and a steam engine to work jointly on the same transmission, when the wind motor serves to relieve the steam engine, thus securing a considerable saving of coal. In the event of the intensity of the wind decreasing so that the wind motor cannot keep up to the speed of the steam engine, another device will throw it out automatically during the time of low wind intensity; the steam engine never has to turn the wind motor round.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

The Cult of the Marine Engineer.

I am not an engineer myself, but as I have always taken a great deal of interest in every branch of engineering, it may not be considered out of place if I refer to the rather acrimonious letters which have appeared in recent issues of the Electrical Review on the above subject. These letters are important in that they show plainly that the men who have risen in the electrical engineering profession, without any technical training, appear to have a dislike for those who have had this training. Now, I desire to say that I think it most regrettable that men should be so envious and spiteful as to write sneering letters about one another's upbringing and education; and from one side to hear sneers about technical education and the colleges where it is taught.

Is it not the opinion of every intelligent man, that it is for the want of technical education that we are not able to compete with certain other countries in many new crafts and industries? This technical education cannot be acquired in the workshops, and a good mechanical training can only be acquired in the workshops of busy engineering firms, where the electrical engineering pupil should be at work for at least two years after he has completed his three years' technical course. But have not parents very great trouble in getting their sons into firms where a good mechanical training can be had, and is it not well known that the firms who want the highest fees are generally those who have the least work on hand? It therefore stands to sense that, under present conditions, it is impossible for more than a

small number of students to get the complete electrical and mechanical training that an electrical engineer should have.

This state of affairs is highly unsatisfactory for the young fellows who wish to have the opportunity given them of qualifying themselves in a thoroughly efficient manner for the profession of electrical engineering; and it may be said that civil and mechanical engineering students are not much better off, as none of the colleges or institutions at which they study are able to send them out fully trained. Could not this complete mechanical, electrical and civil engineering training be given at King's College and a few other places in the country, if the funds were found to provide the laboratories and workshops of these places with all the necessary machinery, contrivances, &c., that would be required to produce the finished article, on a miniature scale or otherwise, from the metal as it is dug out of the earth in its natural state? I believe they could, and that the students' fees and endowments would cover all expenses. This is a question of deep concern to the nation, as the engineering trade in every branch takes first place.

No one will dispute that marine engineers are quite as good as electrical engineers for looking after the running of engines, economising fuel, &c., but the marine man should not forget that the properly-trained electrical engineer has to be skilled in mechanical engineering as well as in electrical work. I, therefore, consider that all employers, borough and urban councils included, incur risk and liability in employing men as charge engineers of generating stations who are not properly qualified electrical engineers, that is, if account is to be taken of the deaths from accidents and shock which are constantly occurring owing to the want of skilled superintendence at works and other places where electrical work is being carried on.

It is well known that the friends of managing engineers are worked in as charge or shift engineers after they have been employed as switchboard attendants or improvers for a short time, so if this kind of jobbery is to be continued, and to be allowed to pass unnoticed by the Institution of Electrical Engineers, what will be the use of parents giving their sons an expensive technical, electrical and mechanical training, for posts that are given to men whose only training has been a year or so on the switchboard, or six or nine months at the job of what is called improver. In time, of course, these men learn electrical engineering from the trained men, and from the excellent opportunities that are placed in their way for the study of plant and appliances; but is it not iniquitous and dishonest of the managing borough engineers who employ this class of man on pay, while at the same time, and in the same works, there are pupils who are paying heavy fees and getting no pay, but on the contrary, as often as not have a most unhappy time of it? These are the same engineers who are a terror to contractors unless bribes or presents are frequently forthcoming.

It is a good thing for England that the majority of Englishmen are above these contemptible practices. The Institution of Electrical Engineers does not seem to do much in the way of upholding the profession, and being a member of the Institution of any grade cannot be considered a guarantee of a man's qualifications.

In my letter on the subject of "Engineering as a Profession," which appeared in the Electrical Review of the 14th ult., I suggested that some qualifying standard should be instituted, or some system by which qualifying certificates could be given to men who can show that they have had an efficient educational and electrical training to admit of their styling themselves as electrical engineers, and to the right of writing E.E. after their names. But to prevent some of the abuses I have referred to, the I.E.E. should make some effort to impress on borough councils and other employers that on employing a new man they should insist on having employers' testimonials and not managers'; and these certificates should contain accurate information of what a man's training has been, and the actual work he has been employed at for three or more years back.

As I have been writing it has come into my mind that we do not seem to be pulling together as a nation and one people; and that we are not nearly so friendly and sociable towards each other as we might be. Of course, every person has a right to choose his or her own personal and visiting friends, but people might be nice towards each other when they meet outside. The point is, that while this sort of feeling lasts the general welfare of the nation must suffer. There is no good got by being jealous and envious of each other. We cannot all be master-men, but we can be good citizens.

There is no reason why we should continue to lose ground and be beaten by other nations, but to keep ahead we must put more energy and will power into our daily life and work, by making up our minds to overcome all the difficulties which may fall in our way. Hard drinking has dragged us down more than anything, as drink stupefies and takes all energy for work out of a man. Through drink the manhood of the country has been degenerating into sloth and laziness, the workman wanting to do as little as possible for his pay, which is higher in these times than it ever was before. This sort of behaviour is before our eyes every day, but it is not the style of Britishers of days gone by, who were men enough to put in a good day's work although their wages were less. Many contractors are driven into bankruptcy by their workmen, for the reason that the workmen take a fortnight to do work which ought easily to be done in a week.

Do not let us forget that all trades and professions are dependent on each other, and the people, all of us, on trade and work for our daily bread. Trade and the exploits of our sailors and soldiers have made England what it is, and unless we keep our trade, our glory and power will fade away. I cannot help feeling disgusted at times when I meet the snob, and hear him, in his ignorance and conceit, run down trades-people. I feel sorry to see that so many people still remain blind to the fact that our trade is going fast, owing chiefly, I believe, to the heavy handicap that we are placed under as compared with other nations. It seems out of all reason that we should have to put up with this any longer. We only want fair fighting.

R. B.

December 7th, 1904.

I have read with much interest the correspondence at present going on in the columns of your paper. With reference to that which appeared in last week's issue, I should like to ask one question. Where is the station to which the correspondent who signs himself "No Name," refers? The staff there must be a truly remarkable one.

In the writer's opinion, the majority of central stations (including his own of over 3,000 kw. capacity) are run by men with no mechanical training at all, let alone men who have served an apprenticeship.

The term "shift engineer" is a most adaptable and elastic one, and is liable to wrong construction, and I am more likely to agree with "Equity" where he says the men who call themselves electricians mostly begin life by sweeping floors. Another point, turn over the "Central Station Directory" and see how many borough electrical engineers have served an apprenticeship, or had a mechanical training. Not 1 in 10! If any profit is to be made by an electrical undertaking, where does the scope lay? Not on the switchboard, but in the engine room and boiler house.

The writer holds that a works staff should be made up similar to the following:—A works superintendent, who should be a trained mechanical and electrical engineer, to have entire control of the station; engineers-in-charge, not switchboard ornaments, but men who know how and who are not afraid of using a spanner, &c, with switchboard attendants or improvers (who have also had a practical training), to take charge of the switchboard and workshop as time goes on.

The present state of affairs is very unsatisfactory. Trained men will not work along with the Finsbury article in the white shirt. I hope this question may be thoroughly thrashed out. Hoping you will find space to publish this.

Voltboy.

Telephone Trunk Apparatus.

There is an instrument in use for indicating the three minutes' conversation allowed for telephone trunk messages, and giving an alarm at the expiry of the time. Perhaps some of your readers may be able to let me know who is the maker of this instrument.

Inquirer.

The Inspection of a High-speed Engine after Overhauling.

May I be permitted to make a few remarks with regard to some of the points in the article which appeared

In no works should one man have an opportunity of trying to lay the blame on another man. If the engineer in authority cannot in his own mind discriminate to whose fault, if anyone's, a breakdown is due, it is not his space to listen to tales from one man about another.

An engine, undoubtedly, should be put together under proper supervision, and not have to be gone over twice to see if everything is in order, and if wrong, pulled down again. For any doubt as to correct valve setting, indicator cards taken with the engine running slowly on atmosphere and a light spring will show all that is required, and it is not necessary to take them at full speed.

The manufacturer sends the engine out to do its best at all loads, and, as a rule, more especially top load. If the engine is not to be fully loaded, or may possibly be, called upon for an overload, it may be necessary to depart from the original valve setting, so that to keep to the original setting is not always best.

An engineer who, having thoroughly examined an engine after erection before the cylinder covers are on, finds he cannot bar the engine round because the piston hits the top or bottom of the cylinder, should hold no responsible place in a power house. If the cylinders and valve chests are well lubricated during erection, it is not only wasteful to run a stream of oil up the sight feed, but undesirable in the case of a condensing engine when the water is returned to the boilers.

To run an engine for six hours unloaded is a waste of good coal, and sufficient information can be gathered in half an hour's run as to bearings being likely to warm up.

When an engine is in regular use, adequate inspection should take place at regular intervals, and the engineer responsible should not wait until something goes wrong before the inspection; the driver should make an inspection of every get-at-able part of the engine every time before starting up, both for adjustment of parts and lubrication. The neglect of this latter rule has undoubtedly been the cause of a good many mishaps to engines in central stations. It is not every undertaking that can afford, after a thorough overhaul of an engine to, after a few days' run, take it all to pieces again to see if it is still in order, nor should it be necessary; and although one cannot be too careful in all these matters, it must not be forgotten that power stations must be run to pay, and engineers must not be led away from the real point at issue, namely, £ s. d., and economies, where possible, must be observed; if they are not, it is little wonder that "high-speed engines have obtained an unfortunate bad name in some quarters in regard to cost of repairs."

S.

McMillan Memorial Fund.

I have much pleasure in announcing that, in consequence of the vigorous appeal by Mr. W. H. Patchell after the annual dinner, the subscriptions received towards the above fund have now brought it up to the full amount of £2,000 which it was always hoped by the Committee to realise. The Committee have reason to congratulate themselves on the generous response of the members on behalf of their late secretary.

G. C. Lloyd,
Secretary, Institution of Electrical Engineers.

92, Victoria Street, S.W.,
December 13th, 1904.

Nernst Lamps.

In reply to "R. A. P." and "Nehpets's" letters in your last issue, we have pleasure in making the following challenge:—We are prepared to replace carbon-filament lamps by Nernst lamps giving the same light, and to demonstrate, after three months' working, a total saving of from 35 to 50 per cent., taking current, all renewals, &c., into full account. Or we are prepared to show that we can give double the light obtained with ordinary incandescent lamps and demonstrate a saving (again taking all renewals into account) of 20 to 25 per cent.

In order to prove our claim we are prepared to install 50 to 100 lamps anywhere in or near London, and to attend to the lamps for three months, we to bear all expenses should we not prove a saving, and "R. A. P." or "Nehpets," or any other electric contractor who would like to take up the challenge, to pay all expenses should our claim be substantiated. Candle-power and consumption tests to be made at loser's expense by a recognised independent expert, the first test to be made before Nernst lamps are installed, the second a month later, and the third at the end of the time.

We are not prepared to arrange the above test on 100-volt circuits, but only on 200 volts, or anything above 200.

Patentees of Nernst Lamps,
A. E. G. English Manufacturing Co., Ltd.

4, New Compton Street, Charing Cross Road,
December 9th, 1904.

Your correspondents *re* Nernst lamps are quite beside the mark. The secret of successful burning of any type lies in a constant voltage, and to over-run the filament is to court disaster. If contractors would ignore the *reputed* voltage of their customers' circuits and ascertain for themselves in each individual case the maximum pressure reached, they would learn some surprising facts, and would know what voltage burner to use to get good results. Incandescent lamp manufacturers have known this for years, and have made lamps accordingly, with the result that comparatively few incandescents would give their stated candle-power if put on their nominal voltage. The same result would be achieved if the makers of the Nernst lamp were to under-mark their burners for the English market. Properly used, the Nernst lamp gives excellent results.

S. W. W.

A Benevolent Fund for the Electrical Industry.

It having been pointed out in many quarters that the electrical industry, although very wide reaching and giving employment and occupation to many thousands of individuals in all grades of life, has in connection with it, no means of supporting any of those unfortunate members who fall into temporary or permanent need, an influential Committee of gentlemen actively connected with various branches of electrical work has been constituted, to organise a Benevolent Fund for the industry.

This Committee has authorised me to announce to you that insufficient time has elapsed to prepare a full scheme of operation, but, as we are approaching the Christmas season, when doubtless many connected both directly and indirectly with the industry are giving gifts in kind and cash, to ask you to make a preliminary notice in your esteemed journal, so that they may earmark or retain some important percentage of these gifts for the Fund.

As soon as a sufficient sum is available, this Fund will be used for the purpose of providing pensions and donations for deserving cases in the electrical industry, voted for by the subscribers.

Further details will shortly be announced, but in the interval the organisation is being rapidly proceeded with.

Justus Eck.

10, Priory Road, Bedford Park, W.,
December 10th, 1904.

[The Fund to which our correspondent refers is one which should appeal to the goodwill of all our readers. We refer to it in our leading columns to-day.—Eds. E.R.]

Working of Battery.

Referring to a letter in your issue of the 9th inst. under this heading, we beg to state that if your correspondent "Batteries" will kindly communicate with us, we shall be very pleased to give him all the information he requires regarding the management of Chloride cells.

The Chloride Electrical Storage, Co., Ltd.
E. C. McKinnon, *Engineer.*

Clifton Junction, *December 13th*, 1904.

Re The British Electric Calibrated Fuse Co., Ltd.

You have inserted a notice in your paper that I have been appointed Receiver for the debenture holder of the above company, and the effect has been an impression that the works are closed. Will you please, in order to counteract this impression, insert a further notice that the works are being carried on as usual, and orders promptly attended to.

George E. Teale,
Receiver Manager.

14, Golden Lane, E.C.
December 12th, 1904.

[Information Wanted.—A correspondent asks for the name and address of the makers or suppliers of a recently introduced spring shade made in cotton or silk, with a clip at the top to clip on to the lower part of an ordinary lampholder. "When the spring was compressed, the clip and the whole shade opened out so that the shade would go over a 16-c.p. lamp, and when the spring was released, the shade clipped firmly on to the lampholder, and the joint in the shade overlapped so that it did not show." We believe that these shades are sold by several of the usual suppliers of electric light fittings.—Eds. E.R.]

ELECTRIC TRACTION ON THE METROPOLITAN RAILWAY.

On Tuesday last, at the invitation of the chairman and directors of the Metropolitan Railway Co., we took part in the first public run from Baker Street to Uxbridge and back in one of the company's new electric trains.

Previously to the trip, the Company entertained the visitors to luncheon at the Hotel Great Central, Sir Charles McLaren, chairman of the company, presiding. There was a large attendance of railway engineers, including representatives of most of the principal English railways, and many distinguished scientific and professional gentlemen, members of the London and provincial Press, &c. After the luncheon the chairman briefly stated that the run about to take place was really the inauguration of electric traction on the company's railway system; electric trains would gradually be interpolated between the ordinary steam trains, and by January 1st they hoped to have the full electric service in operation between Baker Street and Uxbridge. The introduction of electric traction upon the Inner Circle must be carried out in collaboration with the Metropolitan District Railway Co., but would not be long delayed. Their tunnels, which had been built to suit the Great Western broad gauge trains, were the largest in London, and he hoped that when they had been cleaned and whitewashed, they would be found thoroughly satisfactory to the travelling public. The possibilities of London traffic were enormous, provided that every attention was given to the comfort of the passengers. They had been obliged by the pressure of public opinion (and the Board of Trade) to adopt electric traction, and he trusted that this, together with the new carriages, of only two classes, and greatly reduced fares, would immensely increase the traffic, and enable the company to pay dividends on the large expenditure entailed.

The company then embarked on the electric train, and ran out to Uxbridge, the trip occupying 35 minutes, without stops; the return journey took about as long, a speed of 30 miles per hour being at times exceeded. The round trip was accomplished with perfect success, the smooth running of the train being especially noticeable.

Power was supplied from the Neasden generating station of the company, where two turbo-alternators of 5,000 h.p. each are already running; two more are being installed by the contractors, the British Westinghouse Electric and Manufacturing Co., Ltd. The rolling-stock was much admired, the cars, which are, as usual, of the corridor type, being tastefully and comfortably finished, with neatness and simplicity as the ruling features. All the new trains will be of this type, consisting of four trailers, with a motor-car at each end.

Special precautions have been taken in the construction of the rolling stock to provide the maximum safety from fire; all the stock is of British make throughout, having been built by the Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., of British material. The motor-cars each carry four motors of 150 h.p. rating. The electrical equipment was supplied by the British Westinghouse Co., with their latest type of electro-pneumatic train control. The power is brought to the trains by third and fourth rails, both insulated, at 550 to 600 volts; these have been laid entirely by the Railway Co., without in any way interfering with the traffic.

The work has been carried out under the direction of the general manager, Mr. A. C. Ellis, with the assistance of Mr. Thomas Parker, consulting electrical engineer to the company, and Mr. C. Jones, chief electrical engineer. Mr. E. P. Seaton, the company's engineer, has had charge of the line works, and Mr. A. Ingram, the carriage and wagon superintendent, has supervised the construction of the rolling stock.

The very substantial progress which has been made will be good news to those who use the Metropolitan Co.'s lines, and the immense improvement in the conditions of travel will undoubtedly attract a greatly increased volume of traffic, for which the company is determined to provide every facility and encouragement. The shallowness of the tunnels, obviating the delay and expense inseparable from the use of lifts, is a very important and valuable feature of the older underground railways, and when with this are combined the advantages of cleanliness, good ventilation, and high frequency of service, these lines, which, it must be remembered, were the first of their kind in the world, and were constructed at immense cost in the face of very great difficulties, will be restored to their original position as the most convenient and indispensable railways in existence. We cordially congratulate the Metropolitan Railway Co. on the near approach of the new era of prosperity which, we hope and believe, is about to open for them.

LEGAL.

Harrop *v.* Ramsden.

At the Leeds Assizes, on December 7th, 1904, Mr. Justice Darling heard this case, which involved a question of considerable interest to electricians. Mr. Bavistow appeared for the plaintiff; Mr. Compston for the defendant.

The action was brought by Parker Harrop, of Dewsbury, a painter, against his employer, Ned Ramsden, a journeyman painter, for damages for injuries sustained by the plaintiff in his employment. It appeared that on June 24th, 1903, the plaintiff was painting an electric tramway standard in the Dewsbury district. While so engaged his hand came into contact with the live wire, with the result that the plaintiff fell to the ground. Both his arms were broken as a result of the fall. He had been entirely incapacitated from work by his injuries. The defendant in his defence denied that he was guilty of negligence, and alleged that the plaintiff had been guilty of contributory negligence.

The Plaintiff gave evidence on his own behalf. He said that he had not been warned of the danger. He also called witnesses who stated that the use of india-rubber gloves would have obviated any risk. It was also proved that the use of an insulated derrick would have been sufficient protection.

The Defendant, in the course of his evidence, said that he had himself painted about a thousand standards, and had never had an accident of this kind. He always warned his men not to touch the live wire. The use of a derrick would be impossible, as it would be knocked down by the trams. With regard to the use of india-rubber gloves, he had never used them, or considered their use essential.

Mr. Justice Darling, in summing up, said that if a master told a workman to do a dangerous thing he ought to provide him with the means of doing that thing without unnecessary danger. Two things were suggested: (1) That the defendant should have supplied an insulated derrick for the plaintiff's use. This contention was not pressed, because it was shown that a derrick could not have been used while the trams were running; (2) That he should have supplied him with india-rubber gloves. As to this, it was true that if india-rubber gloves had been used, there would have been no accident, but it was for the jury to say whether a man in the defendant's position ought to have known that india-rubber gloves were necessary. Upon this point the only evidence was that of the defendant, who had said that he did not know they were necessary. It was true that evidence had been called to show that india-rubber gloves were often used by electricians; but that was not the point. The jury would have to consider the question with

reference to a man in the position of the defendant. Did he take "proper" precaution? The President of the Royal Society might say that such precautions were proper, but that did not decide the point. His Lordship left the following questions to the jury:—

1. Did the injury to the plaintiff occur by reason of want of proper care on the part of the plaintiff himself?
2. Did the defendant supply the plaintiff with appliances proper to be used?
3. Did the defendant know that it was dangerous to do this work without gloves on?
4. Was the plaintiff guilty of contributory negligence?
5. Damages.

The jury found that the defendant had been guilty of negligence, and that the plaintiff had been guilty of contributory negligence. They assessed the damages at £75. Upon these findings, his Lordship entered judgement for the defendant.

BLACK *v.* DICK, KERR & CO., LTD.

AT Exeter County Court, before his Honour Judge Lush Wilson, K.C., an action was brought by plaintiff, a labourer, against defendants, electric tramway contractors, to recover damages under the Workmen's Compensation Act. The plaintiff claimed 11s. 6d. per week, being half wages during incapacity caused by an accident while he was in the employment of the company.

Mr. E. A. DUNN, for the plaintiff, said that on August 17th, Black was engaged at the London and South-Western Railway goods yard at Queen Street Station, in unloading a truck of tramway rails, one of which fell, fracturing the man's right arm. He was treated at the hospital, of which he had been an out-patient during the past three months. His wages at the time of the accident were 23s. a week, and he was still incapacitated. The facts were admitted, and his Honour had to decide whether the plaintiff was engaged in, on, or about engineering works within the meaning of the Act. After a good deal of legal argument, His HONOUR remarked that the Act was so puzzling that it was difficult to decide what was meant by it.

Mr. K. P. MACKINTOSH, local agent for the contractors, said the practice was to take the rails from Queen Street Station to side depôts. As far as they could they carted them from the railway to the track, but this could not be done to any extent, and the contractors were obliged to take the rails to side streets, or they would be subject to demurrage from the railway company.

Mr. DUNN said his contention was that Black was at the time of the accident engaged in or about the engineering works, which included the construction of the tramways.

Mr. HARRIS submitted that there must be actual physical contiguity between the place where the accident occurred and the works of construction. The physical area in this case was St. David's Station, where the tramway was being laid at the time of the accident. That was the only *locus in quo* entitled to be regarded as the engineering works.

His Honour reserved judgement.

SOUTH LONDON TELEGRAPH TRAINING COLLEGE.

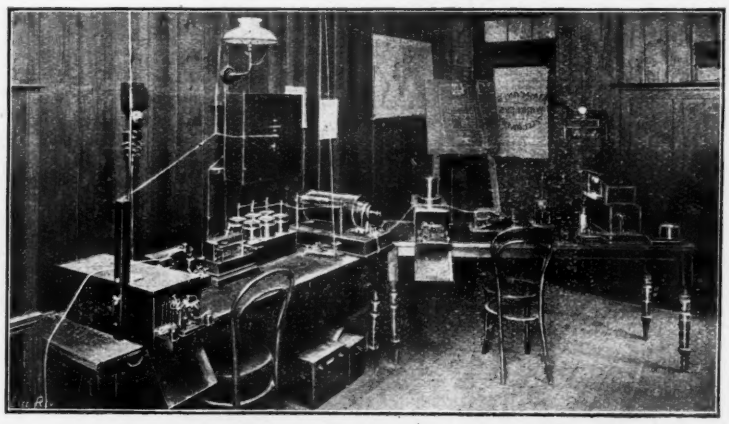
WE recently paid a visit to this College at Raleigh Hall, and 3 and 5, Saltoun Road, Brixton, where for the past 12 years the training of postal telegraph operators has been carried on, with very successful results. The College is now under the control of Mr. W. Lynd, the principal, whose experience in telegraph work goes back to the days of the pioneer companies, and includes wireless telegraphy at the nearer end of the calendar. Mr. Lynd is assisted in his work by specialists:—Messrs. A. J. Townsend, superintendent of the cable department; J. F. Weed, instructor in postal telegraphs; and M. Child, instructor in wireless telegraphy—who have gained their practical experience in the service of the Commercial and Eastern Telegraph Cable Companies, the London Central Telegraph Office, and Lloyd's Wireless Telegraph Division respectively.

The College achieved success from the first, and has from time to time been extended. A cable section was added to train operators for foreign appointments, and was equipped with the latest type of Muirhead siphon recorders; these are arranged to give signals of gradually increasing difficulty, under skilled supervision, until the probationers are able to read with facility messages sent over the actual cables, long or short, as soon as they enter the service of the companies.

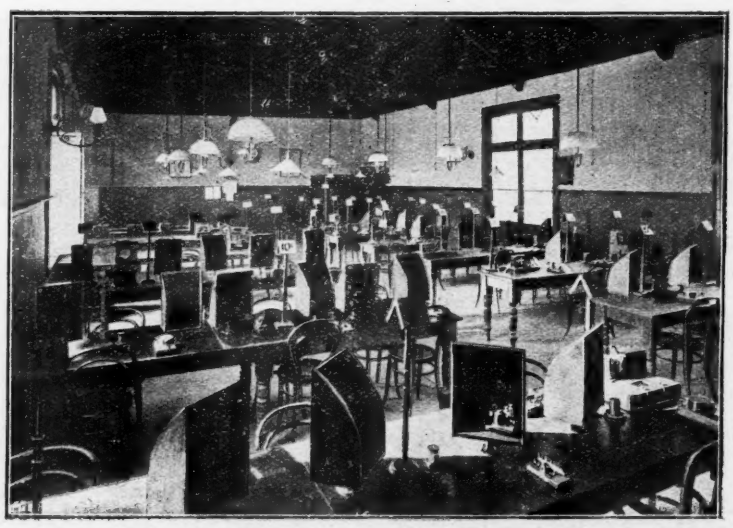
One of the accompanying illustrations shows the main operating room, the further portion of which is devoted to several siphon recorders and transmitters, as well as "spot-chasing" with the mirror receiving instrument. The foreground of the figure is occupied by instruments of the postal telegraph type, which, it will be seen, are arranged as in a large office, so that the students become familiar with their work under realistic conditions. They are, in fact, put through the actual routine, messages being exchanged between the operators in this and a distant room with all the formalities of dating, noting the hour of dispatch and receipt, &c., in due form; they are even taught to transmit sporting news, betting odds, &c., of which, unfortunately, so large a proportion of the postal telegraphic work consists. The extended experience of the instructors in actual office work, in busy cable stations and telegraph offices, ensures the reliability of the tuition.

The most recent addition to the equipment is an outfit of Marconi wireless telegraph apparatus, with which students are taught to fit up, adjust and put in order the whole of the apparatus, besides working it under various conditions.

Our other illustration shows a corner of the "Wireless" room,



PART OF THE WIRELESS TELEGRAPH DEPARTMENT.



MAIN INLAND AND SUBMARINE OPERATING ROOM.

with a Marconi coherer in the foreground on the left hand. Owing to the multitudinous interruptions of electric circuits, and the consequent chaos of electric waves emanating from the adjacent operating rooms, some difficulties were at first experienced in the working of the apparatus; but these have now been overcome, and excellent results are being obtained. Many of the old students of the college are now engaged as Marconi operators on Atlantic liners, and other old students are to be found in telegraph stations all over the world.

The operating rooms provide for the accommodation of 200 students at once, and, in addition, there is a commercial division for instruction in shorthand and typewriting. Power for charging the storage batteries used for supplying current to the various rooms is obtained from a dynamo driven by a gas engine.

Mr. Lynd, who entered the service of the old Electric and International Telegraph Co. at the mature age of 14, is, of course, familiar with all the systems of telegraphy in practical use, and has had a large experience in teaching at other colleges as well as in South London; his enthusiasm and energy, in which his staff vie with him, augur well for the future prosperity of this interesting institution.

THE NEW GUTTA-PERCHA.

For many years past numerous attempts have been made to find an artificial substitute for gutta-percha, which, whilst possessing the essential qualities of that material, shall be procurable at a low cost; it is a plain fact that these attempts have not resulted in success. If it were worth while many years ago to try hard for such a substitute, when the price of gutta-percha was low, it must be much more so at the present time when the price has reached a very high value, and when the natural article itself is becoming comparatively scarce, or, at least, is by no means so plentiful as it used to be in the past.

Although for some electrical purposes the use of gutta-percha has greatly fallen off, it might almost be said has practically ceased (we refer to undergound wires, which are now almost wholly of the paper-insulated type), yet in the case of submarine cables there appears no likelihood that the present system of insulating is likely to be superseded, and therefore the advantages of a cheap and reliable substitute for natural gutta-percha are very considerable, and offer a great chance of being of sound commercial value. The material known as "New Gutta-Percha," which has recently been exploited in an unobtrusive manner, and to which we have on several occasions made reference, seems likely to prove a genuine success, as it appears to possess the elements of durability, good electrical properties, and cheapness.

The material consists of a mixture of pure india-rubber and a sort of wax, the melting-point of which is approximately that of rubber, so that a separation of the component parts does not take place with a rise in temperature.

The electrical properties of the new gutta-percha, or "Gutta Gentzsch" (so called from the name of the inventor, Mr. Adolf Gentzsch, of Vienna), are similar to those of the natural gutta-percha; mechanically, however, the artificial gutta-percha is superior to the natural gutta-percha, in so far as the artificial material can stand a temperature of 60° C. (140° F.) without becoming soft.

In 1902 an order was placed by the Imperial German Government with Messrs. Felten & Guilleaume for a four-core sea cable 8·7 kilometres in length, and this was laid in the same year between the mainland and the Island of Föhr. Each core consists of seven strands of copper wire 0·6 millimetre in diameter, which are covered with "Gutta Gentzsch" to a diameter of 6 millimetres. The four cores are spirally laid up, and wound round with tanned jute yarn, and then protected by an armouring consisting of 14 iron wires of circular section and 5·3 millimetres diameter, served with a double covering of compound. The finished diameter of the cable is about 36 millimetres, and the weight about 3,500 kilogrammes per kilometre. Each core had to fulfil the following conditions: Conductor resistance, 9·6 ohms per kilometre at 15° C.; maximum insulation resistance, 500 megohms per kilometre; maximum value of capacity, 0·15 microfarad per kilometre. Since the laying of this cable, a number of short cables have been successfully laid, and continue in use.

The cost of these cables was, on the average, 35 per cent. less than that of ordinary gutta-percha cables of the same size. The German Government has thus made a saving of 20,000 marks in the 24½ kilometres of "Gutta Gentzsch" cables already laid. In every case the cables, when taken over, gave better electrical results than were specified in the contract.

In laying the cables, the method of making a joint was somewhat modified as compared with that in vogue in ordinary gutta-percha cables. The joints were made partly with natural gutta-percha. Up to the present, the cables have given every satisfaction in working, and no unfavourable reports of any kind have been received.

No very definite statements are made as regards the specific inductive capacity of the material, though there is no reason to suppose that this compares unfavourably with gutta-percha. Even if it were slightly higher, this could probably be made up for by using an additional thickness of the material, without unduly increasing the cost. An important point in connection with the material is that it appears to be stable as regards its specific capacity, the latter having remained unaltered in a core which had been immersed for 12 months in water. Such a result, however, might be expected, as the composition of the material is not suggestive of likelihood of any change taking place.

As regards the insulating properties of the "new gutta-percha," little has been said, and we are pleased to see that this is so, for there is perhaps no fact which is so much used to gull the public as that which states "the insulating property of the new material compares most favourably with that of anything yet produced, its value being many times higher than that of the best gutta-percha. . . ." &c. The unreasoning public naturally assumes that this is a wonderful result, and of great value, whereas the practical electrician knows, or ought to know, that it is not a matter of the slightest moment. So long as the insulation is permanent, it is of no consequence whatever whether the insulation of a core is 500 megohms per mile or 5,000. In fact, in certain cases a very high value is an indication of inferior material rather than of the reverse. The new gutta-percha has evidently come to stay!

BUSINESS NOTES.

Variable Speed Drive for Lathes.—The use of electric power for driving machinery in workshops has increased so rapidly during the last few years that there can be no doubt that this will be the standard system of the future. The direct-current electric motor possesses the quality of speed variation over a remarkably wide range, but this advantage is wanting in the case of the A.C. motor, and even in the former the cost of the motor is greater than that of a motor running always at its maximum rated speed. The need of a good variable speed drive, which has been

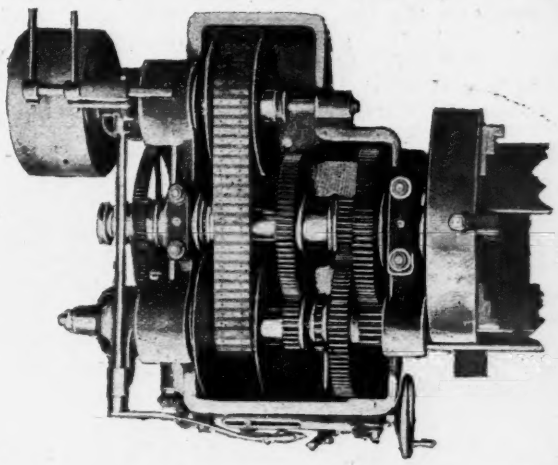


Fig. 1.—Plan of Fixed Headstock Showing Variable Speed Gear.

felt from the earliest times, is therefore still with us. The step cone, almost always used for this purpose, has many drawbacks, chief of which are the abruptness of the changes in speed, and the necessity of stopping the machine whilst effecting the change. To obviate these defects, Messrs. John Lang & Sons, of Johnstone, have brought out an improved form of a well-known gear in which they have such confidence that they have adopted it throughout for the equipment of their new works. The principle involved is that of the friction cone, and in fig. 1 the means adopted is very clearly shown. The driving from the fixed pulley is by means of two dished wheels, which can be moved towards or away from each other on the spindles, while by the same action the wheels on the transmitting spindles are moved similarly and simultaneously in an opposite direction. The belt, the section of which is shaped to fit the cones, is consequently driving from a greater to a lesser

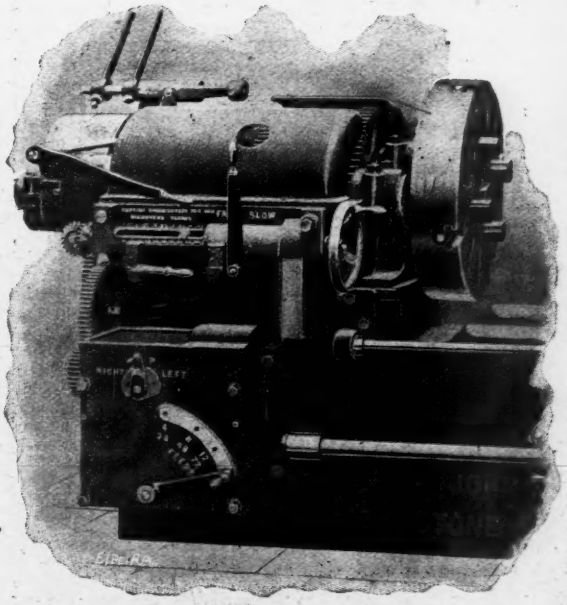
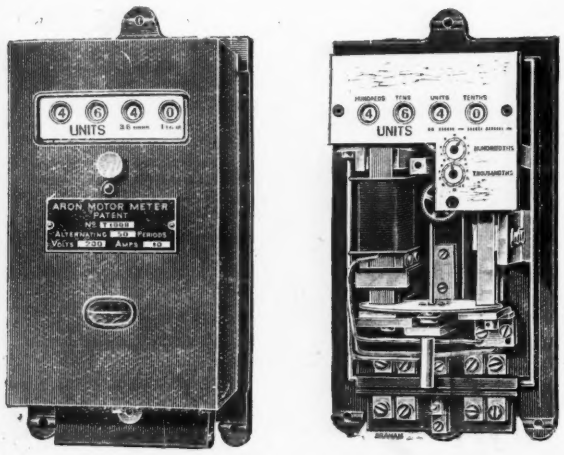


Fig. 2.—View of Complete Fixed Headstock.

diameter, or *vice versâ*, and the variation in speed is most delicate. An ingenious rocking device takes up the slack of the belt. The speed regulation is both "hand" and "automatic." The hand regulation is effected by a hand-wheel conveniently placed as shown in fig. 2, so that the workman can get the correct cutting

speed without handling the belt. The automatic regulation is worked by a special gearing of extremely ingenious design. The operation of changing the speed actuates an index which shows at all times the diameter being turned, while the same index enables the workman when starting to set his machine to the proper speed for the diameter of the work in hand. With the automatic speed-changing mechanism in operation, when surfacing work such as cylinder covers, face plates, &c., the speed of the spindle automatically increases as the diameter being turned becomes smaller, thus keeping the cutting speed of the tool practically constant, and so effecting a marked saving in time. The motor can be bolted to the lathe and drive at constant speed either direct or through reducing gear on to the driving spindle. It may be urged that it is useless to scrap new machinery even for so desirable an improvement, but we are informed that in all recent models of lathes, and in many of the older forms, Messrs. Lang are prepared to fit new headstocks for the variable speed drive, and provide the necessary gears for automatic changing of speed.

A New Induction Motor-Meter.—The following particulars of the Aron induction motor-meter for alternating currents may be of interest to our readers. We give illustrations of the meter, showing its appearance with the case on, and also



Aron Induction Motor-Meter.

with it removed. The counting gear is neither of the ordinary dial order, with moving hands, nor is it a cyclometer train, though it resembles the latter more than the former, having all its advantages and none of its disadvantages. It is impossible to make a mistake in the reading with the Aron counting gear, as each figure is securely locked in its place behind its dial opening, until such time as it is necessary for it to move to make way for the next higher numeral, when it instantaneously springs forward, and the next numeral is then locked in place. This movement is effected by means of a light hair-spring, which is wound up continuously by the revolution of the counting train, and is released every time the figure "0" on this set of figures reaches its opening in the dial. This spring then throws over the unit numeral one division, and is of sufficient strength to move, without fear of any sticking, the whole of the dials, or as many of them as are ready to move to the next higher figure. When the case is removed for testing the meter, it will be seen that there are three springing sets of numerals, which represent units, tens and hundreds of B.T.U., one continuously moving set of figures, which represents the first decimal place (these four are visible through case window), and two small dials with pointers, which represent the second and third places of decimals, so that it is possible to conduct a very exact test without having recourse to revolution counting. The other parts of the meter require little comment. The disk is of aluminium, and runs upon hardened steel pivots in jewelled bearings. The shunt and series windings are so proportioned and relatively placed as to give a strong driving torque with small C R losses. The terminal box and meter case can be separately sealed, and the whole instrument is dust and damp proof, and, as will be seen from the illustrations given, of neat design. The makers guarantee a starting current of 1 per cent. of full load.

The Ohmmeter Principle.—In our article last week on the "Megger," recently introduced by Messrs. Evershed and Vignoles, Ltd., we referred to the adoption of the moving-coil principle as a "fundamental novelty" in the construction of an ohmmeter; we are informed, however, by Messrs. Moul & Co., of 76—78, York Street, S.W., that this construction has been adopted by Messrs. Hartmann & Braun, of Frankfurt-a/M. (whom they represent in England) since 1894, the date and number of their German Patent being No. 75,503, December 23rd, 1893. Instruments of this pattern have been illustrated in their catalogues for several years, but unfortunately they had escaped our notice.

France.—La Société des Voitures Electriques Vedrine is the name of a new company which has been formed in Paris with a capital of £6,000 to manufacture electrical motor-cars.

Trade Announcements.—Mr. Carter, late managing director of the Cross Electrical Manufacturing Co. (now in voluntary liquidation), has joined the staff of Messrs. E. P. Allam & Co., of 11, Hatton Garden, E.C., and requests that customers will send all inquiries in future to his new address. Messrs. E. P. Allam & Co. have purchased the bulk of the stock and plant of the Cross Electrical Manufacturing Co.; and, owing to their increase of business, they have taken the lease of No. 11, Red Lion Street, Clerkenwell Road, E.C., to which address they will remove their offices and works as soon as necessary alterations are completed.

Messrs. Shippey Bros., of 13 and 14, King Street, Cheapside, E.C., inform us that they have been appointed sole British agents for the sale of the Gordon primary battery, made by the Gordon Battery Co., of New York. Messrs. Shippey stock the battery in the following sizes:—100, 300, 600, and 1,000 ampere-hours. Cleanliness and long life are the special claims set up. We have received a full catalogue describing the battery, and giving prices of the same.

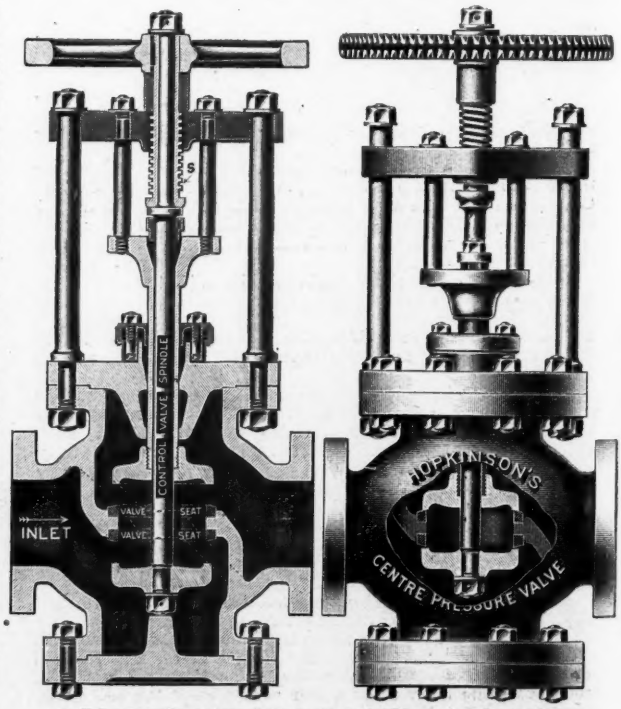
The Great Northern and City Railway Co. will shortly remove their general offices from 18, Eldon Street, E.C., to 3, Highbury Place, N., and on and after the 24th inst. all communications should be sent to the latter address.

We are informed that, owing to the confusion which has occasionally arisen through the similarity of the trade title of Messrs. Littlewood, Beaumont & Co., Thirstin Ironworks, Honley, near Huddersfield—viz., "The Alliance Electrical Engineering Co."—and the title of a London firm, "The Alliance Electrical Co., Ltd.," they have decided to carry on their business in future under the name of "Littlewood, Beaumont & Co."

Hatfield Electric Pumps.—The Admiralty has recently given attention to the application of portable electric pumps for many dockyard purposes, and we understand that Messrs. Merryweather & Sons have received orders for several, each consisting of a "Hatfield" pump driven by an electric motor on a light carriage. They are for use at Devonport Dockyard and at Portsmouth. The pump in question seems to be specially adapted for use in such cases in view of its lightness and the high speed at which it can be driven, in most cases without gearing between pump and motor, saving power which would otherwise be absorbed in friction, and also rendering the machine noiseless in running.

Electricity in Mining.—With regard to Mr. R. Robertson's statement, recently published in the Electrical Review, to the effect that there was not one A.C. plant in a Lanarkshire colliery, we are informed that Messrs. Addie's collieries have been equipped with plant of this description by the British Thomson-Houston Co., Ltd., of Rugby.

Hopkinson's Patent "Centre-Pressure" Stop Valve.—Messrs. J. Hopkinson & Co., Ltd., of Huddersfield, so well known in connection with steam and boiler fittings, have introduced a new type of steam stop-valve, in which several obvious objections appertaining to the ordinary valve are eliminated. Our two illustrations show the valve open and closed. On referring to them, it will be



"Centre-Pressure" Stop Valve, Open and Closed.

seen that a double valve seating is provided in an ordinary valve body. An upper and lower valve are arranged to operate in opposite directions, each positively and independently worked by its own spindle. In opening, it will be seen that, as the lower valve is held to its seat by steam pressure, the rotation of the hand-wheel

merely causes the hollow screw (to which it is keyed) to turn and lift the floating bridge, which, in its turn, lifts the upper and free valve from its seat. Further rotation of the hand-wheel, after the bridge can no longer lift (having engaged with the stops), causes the screw to pass downwards through the bridge, forcing downwards the centre spindle and lower valve, against the steam pressure. In closing the valve, the reverse operation takes place, the lower or control valve closing and shutting off steam (and being held to its seat by the steam pressure), the upper valve following in due course, and without any exertion other than that due to friction in the stuffing box, &c. When closed, it will be noted that the upward and downward thrusts of the valves on their respective seats neutralise each other, and so relieve the valve body, and particularly the lid joint, from all strains. The valve seats are made of Hopkinson's "Platnam" metal, and the valves themselves are free from wings or guides, can move laterally, and thus obviate any chance of sticking. The upper or main valve face and its seat are protected from the cutting action of the steam, because the upper valve is always full open before steam is admitted by the control valve, and does not close until the latter has shut off steam. The control valve is also accessible for examination without disturbing the upper lid. The valve has many good features, and should interest those who have to meet the stringent conditions of high pressure and superheat.

Awards.—Messrs. Pirelli & Co., of Milan, were awarded at the St. Louis Exposition a grand prize for india-rubber goods in general, and two gold medals for insulated wires and cables. Special medals were also awarded to Mr. Emilio Calcagni, Mr. Francesco Piazza, and Mr. Carlo Fratino, of this firm, and a gold medal to their chief electrician, Mr. Emanuele Jona, for a paper on "Insulating Materials in High-Tension Cables," read before the International Electrical Congress at St. Louis.

Catalogues and Lists.—Sheet No. 67 issued by Messrs. Ernest F. Moy, Ltd., gives particulars and prices of their automatic battery switches.

A small pamphlet which has been received from the Dominion Belting and Mill Furnishing Co., of 12, Colonial Avenue, Minories, E.C., gives details of their three leading lines, which are their patent "Campile" belt, "Nut-Tan" belting, and "Brigade" brand canvas belt hose.

The Armorduct Manufacturing Co., Ltd., of 6, Farringdon Avenue, E.C., has prepared a picture postcard giving small photographic views of some of the buildings on Tyneside which are fitted with the company's conduit and accessories, tiny pictures of "Armorduct" parts being inserted in the general design.

A new list (No. 20) of continuous-current series-wound motors for intermittent service has been published by the Electrical Co., Ltd. It is in two sections, one giving particulars of the general construction of the W.D. motors, and discussing generally the question of selecting motors for different services; the other stating prices, torques, outputs, speeds, &c., in tabulated form.

Messrs. Ross, Courtney & Co., Ltd., of Ashbrook Road, Upper Holloway, N., are supplying a new patent terminal which it is claimed does away with the use of pliers or tools, and makes a sure contact without losing the flexibility of the cable.

A pamphlet on "Smoke Prevention Effected by Economical Combustion" has come to hand from Erith's Engineering Co., of Gracechurch Street, E.C. The principles governing efficient combustion are discussed, and the patent Underfeed stoker is illustrated and described.

From Messrs. W. G. Haywood & Co., of 56, High Street, Bloomsbury, W.C., we have received an illustrated price list of their patent motor starting and controlling switches of the open and protected types.

A "Preliminary Catalogue" for 1905 has been issued by the Hozier Engineering Co., Ltd., of Glasgow, showing their Argyll motor-cars. The company is exhibiting at the Palais Royal, in Paris, this month.

Messrs. Dorman & Smith, of Ordsal Electrical Works, Salford, have issued a new edition of their electrical apparatus catalogue, showing reduced prices which have been made possible by improved facilities for production and larger output. The "Grip contact" circuit-breakers which are detailed are in use in many leading generating stations. The "C" type improved chopper switches and various replacement fuses which are shown are supplied either mounted or unmounted for the use of switchboard makers. Other special features are an improved ceiling plate, and other accessories for inexpensive pipe-wiring, a new small size porcelain tumbler switch, a "baffle" type fuse for house service and other purposes, also many designs of iron-cased and other switches and fuses, fuse-bridges, lampholders, reflectors, ceiling fittings, ship-lighting fittings, &c.

The approach of the New Year as usual brings with it a number of useful and excellent pocket diaries. One of Letts's self-opening pocket diaries and note books for 1905, with a £1,000 accident insurance coupon, has been received from Messrs. Thomas Bolton and Sons, Ltd., of Cannon Street, E.C. It is in a very neat binding, and has an appearance of which none need be ashamed.

Messrs. Dick, Kerr & Co., Ltd., of Abchurch Yard, E.C., have just published a revised edition of their direct current generator publication, also a new catalogue describing their alternating current machinery. The former, in discussing the manufacture of large continuous current machines, details the limiting factors which have to be taken into account in designing an efficient machine, and particularises the Preston generators, showing the various parts thereof by means of admirably-executed half-tone illustrations which stand out with utmost clearness on the very fine art paper employed. The views include one of a magnet frame showing the assembling of field coils, one showing the frame moved to uncover armature, others illustrating the assembling of pole-pieces, the casting of magnet frames, the assembling of field magnet spools, segments of core, assembling core segments on armature spider, commutator parts, various stages of armature coils, parts of brush gear, and so on, until, finally, there is a view of complete generators on testing bed. The work on alternating current machinery details the manufacture of this description of plant in much the same way, the particulars of the rotor, stator, and so on, being followed by notes on sub-station machinery. Both books are very fine productions, which the engineer will be anxious to keep by him.

"P.D.M." Electrical Plant.—Among the important contracts which the Phœnix Dynamo Manufacturing Co., Ltd., of Bradford, have in hand at present are the following:—

A 350-kw. traction generator coupled to a triple-expansion engine by Gourlay Bros. for the Cleckheaton U.D.C., to the specification of Mr. A. Pickersgill, the Council's electrical engineer.

Generators coupled to Belliss engines with booster for the Deptford Borough Council, to the specification of Messrs. Medhurst & Lloyd.

To the order of Messrs. Simpsons, of Pimlico, 700-b.h.p. in 12 motors for coupling to centrifugal pumps, &c., for the new electricity works of the Marylebone Borough Council.

Also various other generators, boosters, and motors for Corporations and Electricity Supply Cos.

For a well-known Yorkshire colliery they have in hand a 250-kw. generator coupled to a Willans engine, with various motors, &c. For four other Yorkshire collieries they have generators and motors of over 350 h.p. on order.

For the Croft Granite Brick & Concrete Co., of Leicester, they have two generators and various motors to a total of 230 h.p., with switchboards, &c.

For textile firms in the Yorkshire district and Belfast they have generators totalling over 200 h.p. on order.

For ironworks and engineers in the local districts they have generators of over 250 kw. capacity on order.

In addition to the above, the h.p. of motors, &c., on order for various other customers totals over 1,500 h.p. They have further just set to work for the Bradford Corporation Electricity Works a 300-kw. traction generator coupled to a Willans engine.

Their line of new d.c. motors, which have been designed in accordance with the list of Standards Committee, are reported to be meeting with a very good reception, and in their polyphase department they are experiencing quite an encouraging demand for machines. They have recently completed for the Wednesbury Corporation, to the specification of Mr. F. J. Warden-Stevens, two sets of motor-generators, each consisting of a 125-h.p. two-phase motor coupled to a 75-kw. d.c. generator. They have recently executed orders for polyphase machines for the following amongst technical institutions: — Birmingham University, Birmingham Technical School, Bradford Technical School, Nottingham University College, Lancaster Technical School, and Leeds University. We are also informed that the new Phœnix electrically-driven sensitive drill, which we recently described, is meeting with a good sale, especially among electricity works.

Electrical Driving in Calcutta.—Messrs. Thacker, Spink & Co., the Indian publishers, are adopting a complete electrical driving installation. Over-crowded in their old premises, they are erecting spacious new buildings to contain their machinery, to which important new additions will be made. They are adopting electrical driving throughout and are generating their own current. The two dynamos of 14-kw. each and the 18 motors ranging from 2 to 7½ b.h.p. each, are on order with the Rhodes Electric Manufacturing Co., who are also supplying to the contractors the speed-controlling and starting gear necessary. Messrs. Walter Locke & Co., Ltd., of Calcutta and Lahore, have in their hands the entire order for the plant and installation. They are sole agents in Bengal and the United Provinces of Agra and Oudh for the Rhodes Co., and have already installed many of the latter company's machines. The work comprises two dynamos, switchboard, 18 motors, 221 lights and 13 fans. The current will be generated at 225 volts, and everything will be "made in England."

Newcastle Branch of the Electrical Contractors' Association (Incor.).—On Friday, December 2nd, the second annual dinner of this branch was held at the Continental Restaurant, Newcastle, Mr. Wm. Cross, presiding, and Mr. A. Andrews in the vice-chair. There were present as guests, Mr. Harford, Liverpool; Messrs. Giepel and Prescott, West Hartlepool; Mr. W. P. Steinthal, Bradford; Mr. Eugene Brown, Newcastle; Messrs. Gowdy, Usher and Mr. R. Robson, hon. secretary, members of the committee, and other gentlemen. After the usual loyal toasts, Mr. Cross proposed "The Association," and Mr. Harford replied; Mr. Steinthal proposed "The Newcastle Branch," and Mr. Andrews replied. Mr. Gowdy proposed "The Guests," and Mr. Giepel replied. The chairman gave a very concise report on the work of the Association during the last year, and showed what a great deal of work the incorporation throws on the leading members. Mr. Steinthal said he was glad to propose the toast of "The Pioneer Association," and was pleased to see four of the original five members present that evening. Mr. Andrews remarked that the meeting held the evening before was the fiftieth general meeting of the Newcastle Association. Several songs were given during the course of the evening.

Sequestration.—The estates of John Hill, electrical engineer, 87, Minard Road, Glasgow, were sequestrated on December 5th. A meeting was to be held on Wednesday, 14th inst., to elect trustee and commissioners, and it was expected that a composition might be offered at that meeting.

Bankruptcy Proceedings. — Under the failure of William Watson and George Huntingdon, electricians, trading as Watson & Huntingdon, at 83, Battersea Rise, and Dering Street, Bond Street, W., the first meeting of creditors was held last week at the London Bankruptcy Court. The Receiving Order was made on November 17th, upon the joint petition of Brown Bros., Ltd.,

and the General Electric Co., Ltd. Mr. Egerton S. Grey, Official Receiver, reported that the debtor Watson had stated that he started business as an electrical engineer about 3½ years ago at 41, St. John's Road, Clapham Junction, in partnership with another under the style of Watson & Merry, their joint capital amounting to £100. In October, 1903, they were joined by Mr. Leonard Collier, who brought in £300, and the style of the firm was altered to Watson, Merry & Collier. The partners could not agree, and it was arranged that Mr. Huntingdon should buy out Messrs. Merry & Collier and acquire a one-half share of the business, which, in the following March, was removed to 83, Battersea Rise. In addition to paying out £350 to Messrs. Merry & Collier, Mr. Huntingdon introduced £600 into the business. A branch was opened in December, 1903, at 17, Dering Street, and the two businesses were carried on until last August, when they were assigned to a trustee acting on behalf of the general body of creditors. Certain outstanding contracts were completed by the trustee, who then shut down the business. No accounts had been filed, but the debtors roughly estimated their liabilities at £909, and had in the shape of assets, stock, &c., to the value of £150, and book debts £400. The failure was attributed to loss on contracts and general trade depression. Messrs. Moreton and Clowes attended the meeting for the debtors, and no offer being submitted, Mr. F. S. Salaman, chartered accountant, Oxford Court, Cannon Street, E.C., was appointed trustee to wind up the estate in bankruptcy, assisted by the following committee of inspection, viz.:—Mr. C. E. Waller (Brown Bros., Ltd.), Mr. Lewis Benjamin and Mr. J. C. Lyell. The trustee was desired to give security in a bond for £500, and the debtors were directed to attend the Court on January 24th for their public examination.

December 23rd is the last day for receiving proofs for intended dividend in *re* B. G. Hodges, electrical engineer, Derby. Trustee: Mr. D. Sibbald, 23, St. James's Street, Derby.

Dissolutions and Liquidations.—The first meetings of creditors and contributors of Sir Hiram Maxim Electrical and Engineering Co., Ltd., are to be held at the Holborn Restaurant on December 21st.

A meeting of the Electro-Chemical Co. (1900), Ltd., is to be held at St. Helens on January 18th, to hear an account of the winding up from the liquidator.

Natal.—The value of the electrical fittings imported into Natal during the nine months ending with September last is returned at only £25,000, as compared with £61,000 in the corresponding period of 1903.

Book Notices.—The usual avalanche of "pocket-books" is upon us, all enlarged, revised, and otherwise improved. It is impossible, and unnecessary, to review them all in detail, and we must content ourselves with brief notice of the majority.

The "*Practical Engineer*" *Pocket-book*, published by the Technical Publishing Co., is a very old friend, having now attained its seventeenth year of issue, and, as usual, it has added to its bulk, the chapters on steam turbines and rope-driving especially having been brought up to date. The impending change in patent procedure has led to the complete re-writing of the section on patents. This is really a wonderful shillingsworth. During recent years it has been accompanied by a worthy younger brother, the "*P.E.*" *Electrical Pocket-book*, now six years old. Numerous additions have been made to the latter, including the new Fire Office rules for installing electric motors and dynamos, and the I.E.E. wiring rules, and a new section on patents. While this book is much smaller than its companion, it is of much more interest to electrical men, and contains a vast amount of practical information.

Fowler's Mechanical Engineer's Pocket-book, published by the Scientific Publishing Co., though not so long established as the foregoing, is a very meritorious production, and contains a great deal of information on steam, gas and oil power plant, including a new section on entropy, which should greatly facilitate the use of this function in practical work. Such up-to-date matters as high-speed tool steel and Curtis turbines are dealt with. *Fowler's Electrical Engineer's Year Book*, by the same publishers, contains particulars and data relating to many branches of electrical work, including polyphase currents, electric traction, &c., and a directory of British light and power stations. These two books have the advantage that they open in a convenient manner, like an ordinary book.

The *Practical Electrician's Pocket-book*, published by S. Rentell and Co., has, as usual, been revised and extended, and much of it has been re-written. This is quite a different work from the foregoing, and is rather descriptive than numerical, though tables are inserted where necessary. It also contains brief particulars of the principal British public electricity supplies, and a set of estimating data-forms in addition to the usual diary.

Munro & Jamieson's Pocket-book of Electrical Rules and Tables (Charles Griffin & Co.), the doyen of English electrical pocket-books, has reached its seventeenth edition, and really the mere mention of its name should be sufficient, for every electrical man is familiar with it. Not everyone, however, is the proud possessor of the seventeenth edition, and we may therefore mention that the sections dealing with the testing and localisation of faults in submerged cables have been entirely re-cast, and in great part re-written. The latest rules of the I.E.E. and the B. of T. have been introduced, and other new matter added. This book now contains considerably over 700 pages, nearly all of which relate purely to electrical matters.

Molesworth's Pocket-book of Engineering Formulæ, twenty-fifth edition (E. & F. N. Spon), never lacks popularity, and the thorough revision and re-writing of the Electrical Supplement by Mr. W. H. Molesworth will enhance its value to electrical engineers, though the small space allotted to this section necessarily limits the range of matters dealt with therein.

Australian Mining and Metallurgy. By Donald Clark, B.C.E. Melbourne: Critchley Parker. 1904. Price 21s.—This is the first comprehensive volume dealing with this important subject that has yet appeared in Australia. The prosperity of the Australasian States has been built up on the basis of gold, which is found in many parts of the continent, while silver, copper, iron, tin, lead, zinc, coal and other minerals are also worked; and this book deals exhaustively with the geological conditions existing and the mining and refining methods in vogue at the various mining centres in detail. In this immense industry, unfortunately, electricity plays but an insignificant part; electrolytic processes have not proved successful, and it appears that only in connection with magnetic ore separators, which are in use at Broken Hill for separating slightly-magnetic materials, mainly garnet and rhodonite, from galena and quartz, is electricity employed to any extent. Various types of separators are described, with their working results. There is really an immense virgin field for electric power in Australia, and we hope that when the second edition of this valuable work is produced, electricity will figure largely in its pages.

The Country Gentlemen's Estate Book, 1904, which is edited and compiled by Wm. Broomhall, and is published by the Country Gentlemen's Association, Ltd., of 2, Waterloo Place, Pall Mall, S.W. (5s. 6d. net), contains a mass of valuable matter relating to estate management. Many articles are published in it relating to farming, forestry, gardening, sports and pastimes, estate management and estate work. In the estate management department Mr. Douglas Mackenzie writes on "Motor Transport for Goods." In the estate work section there is an illustrated article on "Making Light of the Wind," showing how windmills may be used for dynamo driving; also a description, with photographs, of the electric light installation at Losset Park and Machrihanish, Argyllshire, for which the water supply of the Kylipole Loch and the adjoining hills is utilised. The work is a very fine production, with many excellent photographic views of country residences, and to those who are interested in this sort of thing, it is worth far more than the price at which it is published.

"Elements of the Differential and Integral Calculus." By W. A. Granville and the co-operation of P. F. Smith. London: F. J. Matheson. New York: Ginn & Co. 10s. 6d.

Who's Who, 1905 (7s. 6d. net).—This work is always welcome, for it is a most useful reference book to have at hand. In view of the large amount of matter that has to be handled in its compilation, occurrences of a latter date than August 30th are not recorded. As was the case in the last issue, the tables which used to form the first part of the book have been deleted in order to emphasise the real purpose of the work, which is that of a biographical annual. These tables are issued as a separate book, *Who's Who* Year Book (1s. net), and they are of considerable value. A companion to these is the *Englishwoman's Year Book*, 1905 (2s. 6d. net), which has also been received. It contains a vast amount of information relating to education, employments and professions, literature, art, music, philanthropy, religious work, public work, and so on. The three books are published by Messrs. Adam & Charles Black, of Soho Square, London.

"Insulating Materials in High Tension Cables." By E. Jona. Milan: Pirelli & Co.

"Inauguration du Buste de M. George Montefiore a l'Institut Electrotechnique de Liège." This work is issued by L'Association des Ingénieurs Electriciens sortis de l'Institut Montefiore.

Calvert's Mechanics' Almanack and Workshop Companion, 1905.—This, the thirty-second annual edition, has just come to hand, and should prove a most useful almanack for working men and apprentices. Much useful information for those in the engineering, building and allied trades is given. The price of the work is 4d., and it is published by Mr. John Heywood, of Manchester and London.

The *Central*, No. 4 of Vol. I., contains well-illustrated descriptions of the Manhattan Railway power station, and the North-Eastern Railway electrical equipment, together with a number of minor articles on various matters of interest.

"The Electrical Transmission of Energy." By A. V. Abbott. New York: D. Van Nostrand Co. London: Crosby Lockwood and Son. 30s. net.

"Small Electrical Measuring Instruments: How to Make and Use Them." *Model Engineer* Series. London: Percival Marshall and Co. 6d. net.

Raworth's Traction Patents.—During the week new installations of regenerative control have been made at Birmingham, Bournemouth and Havre, in each case with a pattern of motor which has not previously been tried—viz., Brush 1002 B, Westinghouse 49 B, and G.E. 1000. An order has also been received to fit up a car for the Corporation of West Ham.

Marchant v. Victor Coates & Co., Ltd.—In the High Court of Justice, Dublin (before Mr. Justice Barton), sitting in the Chancery Division, this case was heard. The plaintiff was engaged by the defendant company, of Belfast, to act as their sole traveller and agent in England, Scotland and Wales, at a salary of £400 per annum, and 2½ per cent. commission. The agreement provided for being determined by six months' notice on either side. The plaintiff (according to a report of the case in the *Dublin Evening Reporter*) agreed not to assist in the sale of competing machinery, and would not undertake the selling of other machinery having a detrimental effect against the defendant company. It was stipulated that the agreement was to continue until October 31st, 1903, and also thereafter until either party should give the other six months' notice on either side to terminate such. He was informed in March, 1903, that the affairs of the company were in a bad way, and was asked to

resign, plaintiff to receive £75 to terminate his agreement. He refused to accept such a sum, and on May 1st, 1903, received notice. The case for the defendants was that they were induced to employ plaintiff owing to his representation that he had a valuable English connection, and that he assisted contrary to his agreement, in the sale of machinery made by Messrs. G. W. Marchant. His Lordship, in giving judgement, stated that the business the plaintiff was engaged in for Messrs. G. W. Marchant was not a competing one, he was not guilty of incapacity at all, and he endeavoured to do his best for the firm. His Lordship said he would award the plaintiff the sum of £35 6s. 8d. in respect of salary, and £266 13s. 4d., making in all £300.

To Arthur William Jackson.—Among our "Official Notices" to-day there appears one which concerns Arthur William Jackson, son of Joseph Jackson, who died in 1867. He is asked to communicate with a solicitor acting for the trustees of a will, and if anyone can put the two into communication they will have done something to Mr. Jackson's advantage.

LIGHTING AND POWER NOTES.

Beckenham.—The U.D.C. has decided to adopt the time switch system; energy used during the period of heavy load will be charged for at the rate of 7d. per unit, and during the rest of the 24 hours at 1½d. per unit.

The South Metropolitan Electric Light and Power Co. has claimed the sum of £7,898 in respect of the sale of its rights to supply that part of the urban district which is covered by the Crystal Palace Electric Lighting Order, 1893, and which part of the undertaking the Council claimed the right to purchase. The Council is now advised that the amount of the company's claim is excessive, and has decided to refer the matter to arbitration.

Blackwood.—The Chamber of Trade has expressed dissatisfaction with the gas lighting of the town, and unless the price is reduced, it has resolved to endeavour to install electricity for lighting purposes.

Bradford.—On Thursday, the 8th inst., a serious breakdown occurred in the electric supply to the city. A heavy short circuit occurred early in the day, and upon investigation a fault was located in a feeder laid across an iron bridge which passes over the main line of the Midland Railway in School Street. The feeder was disconnected, but the fault remained. The pavement upon the railway bridge was opened up, when it was found that the arcing had burned a hole in the iron plates forming the bottom of the bridge. At 8.30 the pavement opposite the Midland Station, in Forster Square, about a quarter of a mile distant from the bridge, was displaced by an explosion. At this point the cables are laid in two parallel brick and stone culverts, and supply energy to the four most important feeding points in the centre of the town. Later, further violent explosions occurred in the vicinity, becoming so serious that at 9.55 a.m. the works were shut down. Further investigations, during which the majority of the positive and negative feeders were removed at four feeding points and at the works, only resulted in continued explosions. Owing to the reduced capacity of the mains between the fault and the feeding points the supply could not be reinstated until midnight. The cables that were the cause of the mishap, and those burned out thereby, were laid between 8½ and 16 years ago, and were burned through in many places at old-fashioned cast-iron straight through joint boxes fitted with rubber glands, the cables having lead sheaths and hygroscopic insulation. The Bradford system of mains has until the last few months consisted wholly of single-core cables, and there are are no fuses upon these. The trouble is attributed to stray currents upon the cable sheaths causing a fault at the point where a cable entered a rubber gland joint box, and thus raising the potential of the lead sheath, the lead sheaths not being electrically continuous across the joint boxes. The distribution to the tramways was unaffected. The contiguity of the cables in Canal Road to one of the largest of the city gas mains caused considerable anxiety, the gas supply not having been cut off, and metal being fused out of the pipes. Considerable inconvenience was caused to the numerous motor users in the city; the damage is estimated to exceed £1,000. The engineer has recommended the T.C. to provide additional traction feeders, and to extend, by means of H.T. transmission, the present area of supply, at an estimated cost of £26,165.

Bridlington.—The T.C., whose electric light works will be opened in the New Year, has decided to supply energy to large consumers as follows:—Over 500 units per quarter, 4½d. per unit; over 1,000, 4d. The ordinary price is 5d. per unit.

Bromley (Kent).—The Electric Power Development Co. has informed the R.D.C. that it intends applying for a prov. order for E.L. in the Council's area.

Burnley.—The first electrically-driven weaving shed in the district was started on 10th inst. at Heasandford. It will have a complement of about 1,500 looms; 400 are now ready for working, and the remainder will be started as soon as complete.

Dudley.—The Council has resolved to raise a loan of £21,000, and in the course of discussion on this question it was pointed out that the original capital outlay on the works was £63,500. The result of the working of the first two years was a loss of £380, and of the second two years a profit of £1,452. Last year's profit was £650. Energy supplied at 1d. per unit to the tramway company—which was the price fixed by the Board of Trade—was the most profitable part of the undertaking.

Dublin.—Mr. Mark Ruddle, the city electrical engineer, has written a letter, which was considered by the Committee of the whole House, and which pointed out that Mr. Hammond's letter of August 25th, 1904, contained certain discrepancies in regard to the estimated cost per unit, and stating that he (Mr. Ruddle) was prepared to undertake to produce electricity as economically as Mr. Hammond, provided the Municipal Council gave him the same facilities as were accorded to Mr. Hammond during the 12 months of his supervision agreement.

Dunfermline.—The T.C. has instructed Mr. Sayers, of Glasgow, to act as adviser to the Council in regard to the laying of mains throughout the district by the Fife Electric Power Co.

Eastbourne.—Mr. J. K. Brydges, the borough electrical engineer, in his annual report, states that the revenue for the past year's working was:—For private lighting, £17,942; power, £234; public lighting, £2,064—leaving a balance, after deducting works costs, of £3,858. £1,000 has been placed to depreciation account, and £750 applied to the relief of the rates. There were connected at the end of the financial year 888 consumers, and a total of 897,193 units were sold. The length of mains laid amounted to 35½ miles, and the low-tension cables are gradually being replaced by those of the concentric type, the high tension being all concentric. Experiments are being made with Nernst lamps, and it is intended shortly to introduce slot-meters. The Corporation is applying for powers to extend its mains to Willingdon village, and the incorporation of this district into the borough is now being discussed.

Erdington.—The U.D.C. has received from the B. of T. an intimation that the question of revoking its E.L. order will be deferred for a year from November 9th; but if at the expiration of that period, active steps have not been taken to carry out the obligations, the order will not be allowed to remain any longer in force.

Ferrybridge.—The P.C. has accepted the offer of the Wheldale Coal Co. for the provision of electric lamps at New Fryston, and for the supply of energy.

Gorton.—The Manchester Corporation has informed the U.D.C. that it is prepared to find arc lamps, &c., for street lighting in Gorton, the cost to be included in the charge for energy, and the Council has appointed a committee to confer and report on the matter. The Gorton U.D.C. recently transferred its E.L. order to Manchester.

Hove.—The T.C. has decided to oppose all applications for E.L. orders affecting the borough.

India.—Darjeeling.—Additions are in hand, according to *Indian Engineering*, for extensions to the hydro-electric plant in this municipality. This is stated to be the pioneer undertaking of its class in India. It was being erected at the time of an earthquake, but suffered very little then. Subsequently, however, a cyclone wrecked many of the lines, and left the electrical plant buried in mud. A new channel has been brought in from the Barbhutra Jhora, crossing the gorge on a suspension bridge made up from the materials of an old telepher line. Water is to be brought first into the original reservoir of some 400,000 cb. ft. capacity, which is to be kept full in reserve; thence it will flow into a new tank of 80,000 cb. ft. A new 200-H.P. turbo-alternator is being supplied by the General Electric Co., of London. There are to be no extra running charges, and it is anticipated that the electric power will be utilised for power purposes in the tea industry.

Simla.—The report of the Waterworks Committee states that Major-General Beresford Lovett's scheme for obtaining water from the Sutlej and putting down a hydro-electric supply installation has been rejected through its original high cost, its high maintenance charges, and the enormous sacrifice of power it entails. Another arrangement has been recommended whereby the north side of Mahasu would be utilised as an additional catchment area with an electric power plant for pumping and lighting; the initial cost of this scheme, which will provide Simla with an additional 600,000 gallons of water daily, is estimated at Rs. 10,00,000, with a further annual outlay of Rs. 1,00,000, including interest, depreciation and repairs, and establishment charges.

Irvine.—At a meeting of the T.C. recently it was moved that a plebiscite of the ratepayers of the burgh be taken on the question as to whether the electric lighting scheme for the town, recently approved of by the Corporation, should be proceeded with. The motion was lost by a narrow majority.

Kirkcaldy.—The revenue for the past year's working of the electricity undertaking amounts to £772, as against £446 for 1903, and the number of units sold 20,663, as against 7,551.

Ludlow.—The T.C. has decided to consent to Mr. W. Norton Corve's application for a prov. order for E.L. on condition that the Council has the opportunity to purchase the undertaking in 20 years, that the opening of the streets be done by the borough surveyor at a fixed charge; that the Corporation be consulted as to the position of the cables, feeding boxes, &c.; that no overhead wires be erected without the consent of the Council; that the price of energy to the Council for lighting public buildings, street lighting, &c., be 4d. per B. of T. unit, with a reduction in proportion if the price to ordinary consumers is lowered to 5d. per unit.

Llanelly.—At a recent meeting of the U.D.C. it was reported that the B. of T. had threatened to revoke the prov. order of the Council, for electric lighting. A deputation on the matter had been received by the B. of T.

London.—BETHNAL GREEN.—The Finance Committee of the B.C. reported on Monday having instructed the treasurer to apply for a loan of £75,000 for electricity works, and £3,200 for arc lamps. The Marian Square site had been found to occupy 7,337 sq. yards. It was proposed to use 3,087 sq. yards for the electricity works. The total cost of the entire site was £25,000, and it was intended to allocate £10,519 12s. 2d. of this to the lighting undertaking.

ST. PANCRAS—A feeder cable is to be extended by the Lighting Committee of the B.C. into Hawley Road, at an estimated cost of £2,850, and the work is to be commenced in January, subject to favourable conditions.

The Special Committee appointed to take action with regard to the decision in the action for vibration, &c. (Colwell *v.* The Borough Council), reported being unable to acquire further interests in property near the central power station in consequence of the excessive prices demanded. Every care was being taken to prevent vibration, dust, noise, &c., from the works.

CITY.—The Charing Cross and Strand Electricity Supply Corporation has resolved to apply to the Corporation for its approval to an alteration in standard pressure of supply from 100 to 200 volts.

ISLINGTON.—Reporting on Wednesday, the Finance Committee of the B.C. announced having passed estimates (*a*) of £4,000 for providing and laying H.T. distributing mains in the Newington Green district; (*b*) of £1,050 for extending lighting and power mains, principally to supply energy for lighting tube stations in York Road and Gillespie Road; (*c*) of £220 for mains extensions in Highbury Crescent and Caledonian Road.

Macclesfield.—The T.C. has appointed a deputation to wait upon the B. of T. and request it not to revoke the E.L. order, as the Council will commence the works authorised by the order when it considers there is sufficient demand for energy to make the undertaking pay its way.

Messrs. Foote & Milne, Ltd., have intimated that they intend applying for a prov. order for E.L. in the town.

Macroom.—The local E.L. Co. has informed the U.D.C. that it is its intention to increase the charge for public lighting from £75 to £100 per annum, and also to increase the charge for lighting the Town Hall. The Council has declined to pay these increased charges, and has also informed the company that the public lighting for some months past has been insufficient and unsatisfactory.

Metropolitan Asylums.—The M.A.B. has decided to accept the alternative rate of 7d. and 1d. per unit, one hour maximum demand, as from January next, offered by the Hackney B.C. for the lighting of the Eastern Hospital, &c., in place of a supply at 4d. per unit, flat rate, with discount of 10 per cent., and thereby effect a saving of about 40 per cent. in the cost of electrical energy. Tenders are to be called for wiring the Belmont Asylum.

New York.—The Board of Aldermen on December 2nd passed a resolution calling for the preparation of documents enabling the city to install and operate a municipal electric lighting plant, plans for which have been under discussion since March. Public electric lighting commenced in Manhattan in 1881, at $225.50 per lamp. The price gradually decreased until 1890, since when it has remained steady at $146 per 2,000-C.P. arc lamp. The following shows the cost per 2,000-C.P. street arc lamp of the more important American cities, for underground and overhead services respectively:—New York, $146.00, $146.00; Chicago, $137.50, $103.00; Boston, $120.45, $120.45; Philadelphia, $110.56, $110.56; Providence, $109.50, $109.50; Baltimore, $99.92, $99.92; Milwaukee, $99.00, $81.00; Jersey City, no underground, $97.50; St. Louis, $96.38, $96.38; Newark, $95.00, $95.00; Pittsburg, no underground, $96.00; New Orleans, $90.00, $75.00; Louisville, no underground, $84.00; Washington, $80.00, no overhead; Cleveland, $75.00, $75.00; Los Angeles, no underground, $81.00.

The general conditions as to hours, cost of fuel, proportion of underground and overhead wiring, &c., for New York are at about the average of the other cities, except that New York's contract has to be made annually. After tabulating and analysing the data, Mr. Chas. F. Lacombe, the city's engineer of surface construction, concludes: (*a*) that the city is a very large consumer of electricity for lighting, and also of gas (costing $1.20 per thousand feet); (*b*) that the prices now paid are very high, and that at the existing rates it will be difficult to find enough money to keep pace with the growing needs of the city's lighting; (*c*) that New York pays a higher price per lamp under similar conditions than any other city, and nearly the highest price for gas; (*d*) that relief from the present high charges is impossible under present conditions, there being no real competition among the lighting companies. Mr. Lacombe also shows that New York, using 4,748 arc lamps of various candle-power, pays from $125 to $146 per lamp per annum, whereas Evansville, Indiana, with 300 lamps, pays only $60 a lamp. Of the 175 cities given, 91 buy their energy from public companies; 68 of these use lamps of 2,000 C.P. at an average price of $88 60, Evansville, Ind., being the lowest, and Haverhill, Mass, being the highest at $125 per lamp. Six of the cities operate their own electric lighting plant, at an average cost of $66.45 per lamp, ranging from $47 at Columbus, Ohio, to $96 at Jacksonville, Florida. Mr. Robert G. Monroe, the lighting commissioner, attributes the high charges partly to the over-capitalisation of the local companies, the New York Edison Co. having a total capitalisation of $85,338,000, as against an original capital of $30,214,100 of the companies now consolidated under the above title.

The total cost to the New York Edison Co. for generating and distributing energy is probably less than 3 cents per KW.-hour at the lamp terminal. A pair of lamps, such as are used on Fifth Avenue, take about 750 watts, and consume in one year, on the basis of 4,000 hours' burning, 3,000 KW.-hours, equivalent to $45 per single lamp. The difference between $90 per pair and $182.50 (as bid for 900-C.P. lamps per pair) includes maintenance, interest and profit. The total cost of maintenance should not, at the outside, be $10. The estimates for a complete installation for public lighting in New York City, that is, for streets and public buildings (it not being proposed to sell energy to private consumers) are as follows:—

COST OF CENTRAL STATION.

Boiler plant for 10,000 H.P., with economisers, stokers, superheaters, piping and foundations	$500,000
Vertical engines, with condensers, foundations and piping	325,000
Generating plant of 10,000 KW., including generators, exciters, switchboards, &c., erected	300,000
Building and excavations	250,000
Total	$1,375,000

This is equal to $137.50 per KW., or more than the cost of the plant operating the New York subway.

COST OF PLANT.

Power plant as above	$1,375,000
High pressure feeders	260,000
3,500-volt feeders (suburban)	40,000
Incandescent distributing circuits	90,000
Constant current transformers for 12,000 lights	120,000
Constant potential transformers, 7,500 KW.	75,000
Sub-station switchboards	75,000
Arc lights cables and circuits	590,000
Distribution structures	50,000
Arc lamp poles	495,000
Arc lamps and fixtures	250,000
Five sub-station buildings	100,000
Land sites for sub-stations	165,000
Engineering and contingencies	370,000
Interest during construction	143,000
Total	$4,208,000

Of this total, $3,006,000 is assigned to the cost of arc lamps, and $1,202,000 for incandescent globes, or an average cost per arc lamp of $309.69, and $300 50 per incandescent lamp. Cost of generation and distribution is given at $367,500 per annum, based on a comparison of the statistics of the local electric companies, or an average cost of 1.27 cents per KW.-hour. With energy at this price, and allowing $5 for maintenance, $20.20 for depreciation, and $10.50 for interest, the total cost per annum for each 2,000-C.P. arc lamp would amount to $66.10 With similar allowances, the cost per KW.-hour for each incandescent lamp would be 5.475 cents. There would, therefore, be an estimated annual saving to the city of $507,000, arrived at as follows:—

	Present rates.	City plant.
5,000 arc lights	$780,000	$404,000
Incandescent, 4,000,000 KW.-hours	400,000	219,000
	$1,130,000	$623,000

The resolution, endorsing the above estimates, was passed with only one dissentient, whose objection was that it did not include a proposal for supplying energy to private consumers.

New Zealand.—STRATFORD.—The sixth annual report and accounts of the local Electrical Supply Co. show a gross income of £1,807, and a gross expenditure of £1,188, leaving a balance of £619; depreciation and other expenses absorb £256, and after paying a dividend of 8 per cent., a balance remains of £95, which has been carried forward. The total working capital of the company, which includes a bank overdraft of £3,789, is £7,649.

Paris.—The *Times* states that as the present concessions for electric lighting in Paris expire in 1907 and 1908, the Municipal Council will shortly have to consider the question of renewing them or taking the supply of electricity into its own hands. The latter possibility has brought the electric lighting industry to a standstill. A municipal commission of inquiry has been appointed to consider the question. Whatever the decision may be, a considerable reduction of price is to be anticipated on the expiry of the concessions and the consequent creation of a large demand in Paris for electrical apparatus and machinery of all kinds.

Wentworth.—Wentworth Woodhouse, the seat of the Earl Fitzwilliam, is to be lighted throughout by electricity. Mr. E. Wingfield Bowles, of 28, Victoria Street, S.W., prepared the scheme, which is of large dimensions from the point of view of private installations. The works have been erected on a site close to the village of Wentworth, and in proximity to the private gas works. The plant installed comprises two low-speed multipolar D.C. Paxman-E.C.C. sets of 60 KW. each; two steam is supplied by two Davey, Paxman economic boilers; a storage battery of 111 cells and boosters by the E.C.C., have been erected; about five miles of lead-covered mains, supplied by Messrs. W. T. Glover & Co., have been laid in Howard troughing, and also about 2½ miles of armoured telephone wires put down. The extensive wiring of the mansion, which contains many fine art fittings, &c., has been carried out by Messrs. V. G. Middleton, of Westminster. The gas plant, and an old beam engine used for driving the machinery in the workshops, will be entirely superseded by electricity. The chief houses on the estate, the kennels, stables, &c., are all wired for the electric light.

Stratford-on-Avon.—The Birmingham Installation Co. has completed its agreement with the Corporation for the transfer of the latter's E.L. prov. order, and the assent of the Board of Trade is now awaited. The company will open offices in the town, and Mr. C. D. Falcke will be in residence for the carrying out of the work. The specifications for the plant, &c., required, we are informed, will not be ready before March.

Sunderland.—At the annual dinner of the electrical staff of the Corporation, held on 7th inst., the chairman of the Electricity Committee stated, in regard to the growth of the undertaking, that at present 114 miles of cable were laid, and whereas the output for the first year's running was 96,000 units, now it was 110,000 units per week. In 1900, 640,000 units were distributed; in 1901 that figure was doubled; in 1902, 2,375,000 units; in 1904, 3,500,000; and the estimate for the current year was 4,650,000. At the end of the year they expected to add £9,000 to the sinking fund, and he hoped soon to indicate a reduction in price.

Swansea.—At a recent meeting of the E.L. Committee it was reported that the recent failure of a balancer was due to mechanical defects, the machine being completely wrecked. The specifications for lighting the Morristown district are practically complete; the supply will be on the single-phase H.T. system, which may be extended to the Skelty district. The overhead and cable work for the new tramways is progressing satisfactorily.

Tottenham.—Two tenders were received in response to the advertisement of the T.C. for offers to undertake the supply of electricity in the district. The Committee recommended the Council to accept one of two proposals submitted by the North Metropolitan Electric Power Supply Co., but that before entering into an agreement with the company the opinion of an independent expert should be obtained on the matter, but the subject has been referred back for further consideration.

West Ham.—Mr. W. J. W. Bullock, the borough electrical engineer, stated at a recent B.C. meeting that there was an outcry against the maximum demand system, and he believed a large number of consumers would prefer to be charged a fixed rate, even though the yearly bill was greater. It was resolved to offer an alternative flat rate of 4d. per unit, the rates for arc lighting to be 4d. per unit for 700 units per annum, 3½d. for 1,400 units, and 3¼d. for over 1,400 units; factory lighting, 2½d. per unit up to 5 p.m., and the ordinary rate after.

West Kent.—The local authorities have resolved to hold a conference to consider what steps shall be taken with regard to the applications for prov. orders for E.L. to be made by the London Electric Power Co., the City of London Electric Light Co., the Kent Electric Power Co., and the Kent Electric Power Syndicate.

Whitefield.—The U.D.C. has asked Bury T.C., Salford T.C., and Radcliffe U.D.C. to quote terms for the supply of energy for lighting purposes.

Whitwood.—Owing to the revocation of the West Riding E.L. order, the U.D.C. has resolved to apply for a prov. order for electric lighting.

Upton.—The Birkenhead T.C. has fixed the following scale of charges for energy supplied to consumers in Upton:—From October 1st to March 31st, for the first hour and a half of maximum demand, 8d. per unit; for the second hour and a half, 6d.; afterwards, 2½d. From April 1st to September 30th, for the first half-hour, 8d. per unit; for the second half-hour, 6d.; afterwards, 2½d. The supply commenced on December 5th.

Workington.—The T.C. has decided to petition the B. of T. to extend the E.L. order, 1901, and that if the Board shows hesitancy, a deputation should wait upon them and state the case for the town. Up to the present no steps have been taken to carry out the order, and the B. of T. has intimated that it will consider the advisability of revoking the order.

TRAMWAY AND RAILWAY NOTES.

Baker Street and Waterloo Railway.—£11,200 has been awarded to Mr. A. E. Jennings, as compensation against the Baker Street and Waterloo Railway Co., respecting freeholds in Edgware Road and Bell Street, which have been acquired for the Edgware Road Station of the new tube railway.

Barking.—The U.D.C. has applied to the B. of T. for a loan of £8,100 for tramway purposes.

Glasgow.—At a meeting of the T.C. specially convened for the purpose of consideration of provisional orders to be promoted by the Corporation in Parliament during the forthcoming session, the proposed tramway extensions were dealt with. These came up in the Glasgow Corporation (Tramways Consolidation) Order, 1905. Objection was taken to the extension of the system from Maryhill to Canniesburn Toll on the ground that when the proposal was formerly before the T.C. about 90 per cent. of the residents in Bearsden petitioned against it. Councillor Stewart assured the T.C. that these people had deliberately removed their residences to this place in order to escape those nerve-destroying tramcars. The convener of the Tramways Committee said that the present proposal was quite different from last year's. They then intended to go to Milngavie and Bearsden, and the people of these places spoke out against it. All they proposed now was to extend the line by half a mile from the present terminus. The extension was approved. The extension from Barrachnie to Baillieston was also passed. A discussion arose over the extension from Tollcross to Uddingston. Councillor James Macfarlane moved that this clause be withdrawn from the order. He pointed out that the award in the reference regarding their running powers over the Paisley lines gave them only 1d. per car-mile from Hawkhead to Paisley, and they knew it was impossible to run a car at that rate. Councillor Hugh Alexander, the convener of the Tramways Committee, thought that Mr. Macfarlane should not refer to that matter. The award had not been accepted, and the matter might eventually go into the law courts. The Lord Provost said that Mr. Macfarlane was commenting upon an award that had not been formally given, and he might be putting a misinterpretation upon it. It had not been accepted as final by parties, and it was on that ground that his Lordship suggested caution. Mr. Macfarlane thereupon withdrew his motion. Councillor King, however, moved disapproval of the clause, on the broad principle of profit and loss. He held that they were not justified in supplying cheap transit to people outside the city at the expense of the Corporation. The existing terminus at Tollcross was half a mile outside the city boundaries, and they were now asked to go another 4½ miles to Uddingston. He held that the extension would not be remunerative. The amendment was not seconded, and the clause was approved. The extension from Spier's Bridge to Barrhead was also passed. Bailie James Hunter moved that the clause be deleted on the ground that there was no population to provide for on the route, nor was there likely to be for 20 years. In supporting the proposal, Councillor W. F. Anderson said they had already got into trouble with Mr. Murphy at Paisley. He was to construct a line from Paisley to Barrhead. When he got there, he had only to run cars two miles to meet their line at Spier's Bridge. The Act gave them six years to make the line, and if, by the end of that time, the district had not developed, they did not require to proceed with the undertaking.

At a special meeting of the T.C. approval was asked of a clause in a provisional order which the Corporation is to promote in Parliament during the next session to the effect that only one-fourth of the annual value of the underground or overhead lines, pipes, cables, or apparatus belonging to the Corporation should be taken for assessment purposes. Bailie Murray moved that the clause be deleted on the ground that it subsidised from the rates the telephone and electricity departments, so that instead of bearing their full share of the taxes, they would be subsidised to the extent of three-fourths of their proper taxation. The clause was approved.

L.B. & S.C. Railway.—It is said that the first section of this railway to be electrified will probably be that between London Bridge and Victoria.

Leven.—The Buckhaven T.C. is petitioning the Secretary of State for Scotland and the County Council in favour of the tramway from Kirkcaldy to Leven. Mr. Wemyss said the County Council were imposing conditions which would make it impossible to go on with the scheme. It meant a sum of £8,000 to £10,000, and it was nothing else than a species of blackmail. The scheme is being gradually licked into shape, and the proceedings have so far advanced, that Mr. R. G. E. Wemyss, of Wemyss Castle, the promoter, will lodge an application this month for a provisional order to authorise its construction.

London.—The Streets Committee of the Corporation, which has been considering the request of the L.C.C. to agree to a proposal for connecting the present tramway termini in Blackfriars Road and Westminster Bridge Road, by the construction of tramways between those points *viâ* Blackfriars Bridge, Victoria Embankment, and Westminster Bridge, has decided to adjourn further consideration of the matter until the new year, as by that time the report of the Royal Commission on London Traffic may be issued.

Musselburgh.—The new electric lighting and tramway system was inaugurated on Monday in presence of about 300 guests. The National Electric Construction Co., Ltd., London, have put down the plant and made the track, and the cost of the undertaking is stated at from £90,000 to £100,000. The power station is in the centre of the town, and contains three water-tube boilers, three engines, each of 150 H.P., driving dynamos, a battery, workshops, offices, &c., and adjoining are car-sheds to accommodate a dozen cars. The tramway system extends from Levenhall to Joppa, and is slightly over three miles in length. The track is double for two-thirds of the distance. The company has booked orders for nearly 4,000 8-C.P. lights. Mrs. Simpson, wife of the Provost, having switched on the light, Provost Simpson, Musselburgh, declared the undertaking inaugurated.

Newport (Mon.).—The borough engineer has been authorised to carry out alterations to the extent of £200 at the car-sheds, rendered necessary by the decision of the Corporation to have what repairs are required carried out, as far as possible, at the power station.

New York.—A New York correspondent writes:—"The total number of passengers conveyed over the subway during the first complete month of operation was 5,838,235, or a daily average of 201,318, representing, at 5 cents each passenger, daily receipts of $10,065.90. The eastern extension along Lennox Avenue is now opened for business, and the time tables have been modified to allow on paper a two-minute service all day, and a one-minute service during the "rush" hour; but since the Lennox Avenue line has been used, the increased traffic has led to numberless irregularities. The quality of the air in the subway is still the subject of discus-

sion and scientific analysis, and the acrimonious controversy regarding the placing of advertising signs at the stations is still unsettled, although the Interborough Rapid Transit Co. show signs of yielding to the public clamour for their removal. A great number of plans for additional subways are being introduced officially and unofficially, but the Rapid Transit Commission shows so little grasp of the problem, that in some quarters there is a call for the abolition of the Commission. The tunnel under the East River to connect Manhattan with Brooklyn is practically finished, and nearly ready for the laying of rails, and in Brooklyn excavation is being pushed forward at the rate of 13 ft. a day. Mr. William Barclay Parsons, the chief engineer of the Rapid Transit Commission, resigned his position on November 30th, in accordance with his previously announced intention. His successor has not been nominated. The salary is $15,000 a year. On the same day the members of the Manhattan Club gave a complimentary dinner to Mr. J. B. McDonald, the contractor of the subway, and presented him with a bronze statuette. Mr. McDonald prophesied that in 1905 the subway would convey 500,000,000 passengers, and that when the whole system was completed, its carrying capacity would be equal to that of all the steam roads in the United States. The New York Central Railroad is actively proceeding with its electrification plans, and is also buying up a number of tramway lines adjacent to its system in various parts of the State of New York."

Penge and Beckenham.—A local correspondent writes:—"A curious deadlock has been created in connection with the tramway extension from the South Norwood (Croydon line) terminus to Penge. The British Electric Traction Co. had promised to complete this extension by July next; but this line is ultimately to be continued from Penge through Beckenham, and as a part of highly satisfactory terms, the Beckenham Council secured the option to supply the B.E.T.C. with current for the Penge tramways. The Beckenham Council, too, will construct and lease the Beckenham line to the company, and have four years in which to complete the work. The Beckenham Council have now just decided to refuse to supply the current for the Penge tramways until the Beckenham line is completed, when they state they will be prepared to exercise their option as they are legally advised they are entitled to do. If, therefore, the B.E.T. Co. decide to complete the Penge line by the time promised, they will have to obtain a temporary supply of energy from another source."

Perth.—The T.C.'s decision not to proceed with the Dunkeld Road section of tramways was under discussion at the Town Council on Monday night. It was agreed that Treasurer Lawrie, Councillor McNab, and the City Chamberlain report to the Council on the matter.

Plymouth.—The Tramways Committee has recommended the T.C. to apply to the B. of T. for a loan of £6,450 for the construction and equipment of the tramway from Pound Street to the borough boundary at Pennycomequick.

Preston.—The opening of the first section of the Corporation tramways took place on June 7th last, and we are enabled to give a few particulars concerning the new undertaking. The length of street route is 8½ miles, and of track 14 miles; the rail gauge is the standard 4 ft. 8½ in., the rails being 95 lbs. bonded with "Chicago Crown" bonds. The maximum gradient on the system is 1 in 16, and the minimum curve radius 39 ft. 6 in. The overhead construction is practically span wire throughout; a few brackets, however, have been erected. St. Helens "Dialite" feeders supply energy from the tramway power station, which is the property of the Corporation, the plant equipment consisting of two compound-wound Dick-Kerr generators driven by two Cole, Marchent & Morley engines, the total capacity being 600 KW. Steam is supplied by two Lancashire boilers supplied by Messrs. Yates & Thom. The rolling stock consists of 26 double-deck single truck cars and 4 double-deck maximum traction truck cars; 25-H.P. motors are fitted to each of the smaller cars, and 30-H.P. motors to the bogies. Messrs. Dick, Kerr & Co. supplied the bodies and equipment, and the J. G. Brill Co. the trucks. Each car is fitted with the usual swivel trolley. The contractors for the overhead work were Messrs. Dick, Kerr & Co., who sub-let to Messrs. R. W. Blackwell & Co. The general manager and electrical engineer is Mr. Walter H. Tittensor.

For the first 20 weeks' working, ended October 26th last, the average weekly receipts have worked out at over £500. The car-miles run amounted to 230,808; the number of passengers carried 2,525,914, equal to 21 times the population; the total revenue, £11,868; the total expenditure, including £3,871 for sinking fund and interest, and £532 for the same purpose on the old tramway account, amounted to £8,997, leaving a net balance of £2,691. The receipts per car-mile equalled 12·36d., and the expenditure 9·269d.; 283,191 units were generated, being equal to 1·23 per car-mile. A further reduction in working costs is anticipated, as, owing to the haste to commence running the cars, the power station has been working under adverse circumstances. The plant was working for some time without economisers, or lagging to the steam pipes, and the condensing plant is not yet in operation.

Switzerland.—A concession has been granted to MM. K. Muller, Ad. Tschan and G. Holliger, of Soleure, for the construction and working of an electric funicular railway from Oberdorf to the top of the Weissenstein, the cost of the construction being about £27,720.

West Ham.—The half-yearly income and expenditure account of the municipal tramways, issued by the borough treasurer on Tuesday, showed the gross revenue to be £30,748. The working expenses were £17,350. On the net revenue account there was a credit balance of £8,848. An unappropriated balance from the previous six months brought this amount up to a total of £9,179, which he recommended should be disposed of as follows:—Sinking fund, £2,162; moiety of contribution to borough fund, £4,000; contribution to reserve or renewals fund, £3,016. The report was adopted.

Wolverhampton.—A balance-sheet has been sent to certain members of the T.C. dealing with the financial aspect of the Lorain system of electric traction for the six months ending September 30th. It shows a profit of £1,442 on the six months' working, whereas there was a loss of £262 on the corresponding period of the previous year. The total receipts for the six months are given as £18,678, against £12,461 in the corresponding period of last year. The total receipts per car-mile are 11·85d., against 11·2d. in the corresponding period; receipts per car-mile (passengers) 11·7d., against 11·1d.; average receipts per passenger 1·183d., against 1·25d.; total costs per passenger 1·105d., against 1·29d.; working costs per passenger ·635d., against ·79d. From the analysis of operating costs it appears that £7,457 is the total; average cost per car-mile 4·72d.; against £5,628, and 5·08d. last year. Under the head of maintenance and renewals, the total cost is £870; average cost per car-mile ·55d.; as against £825, and ·74d. last year. The total maintenance cost of Lorain equipment is set down at £380; average cost per car-mile ·24d; against £244, and ·22d. last year. Next we come to total general costs, which amount to £1,205, against £1,102, and ·99d. last year. Total working costs are £9,911, against £7,799 11s., and 7·04d. last year. Capital costs come last in the statement, and the total is given as £7,325, against £4,923, and 4·44d. last year. The T.C. on Monday, on the recommendation of the Tramway Committee, decided to purchase the surplus tramway material and stock of the Lorain Steel Co. for sale on the closing of their depôt at Cleveland Road, at reduced prices, the total sum to be paid being £350 or thereabouts.

TELEGRAPH AND TELEPHONE NOTES.

Amazon Telegraph Rates.—In our issue of November 11th last we had occasion to refer to the Amazon Telegraph Co., and we have now been advised that the increase in rates there referred to has been given effect to as from January 1st. The rates have been increased by 50 per cent. We shall watch the result with much interest.

Cable Repair.—Some time ago the Commercial Cable Co.'s Azores cable became injured some distance from the Irish Coast, and the services of the Eastern Telegraph Co.'s cable-repairing steamer *Norse* were requisitioned to localise the injured portion of the cable and carry out the repair. This has now been completed. Another of the Commercial Cable Co.'s trans-Atlantic cables at present needs repairing, about 30 miles distant, it is supposed, from the Kerry coast, and this work will also be undertaken by the *Norse*.

Telegraphic Interruptions and Repairs:—

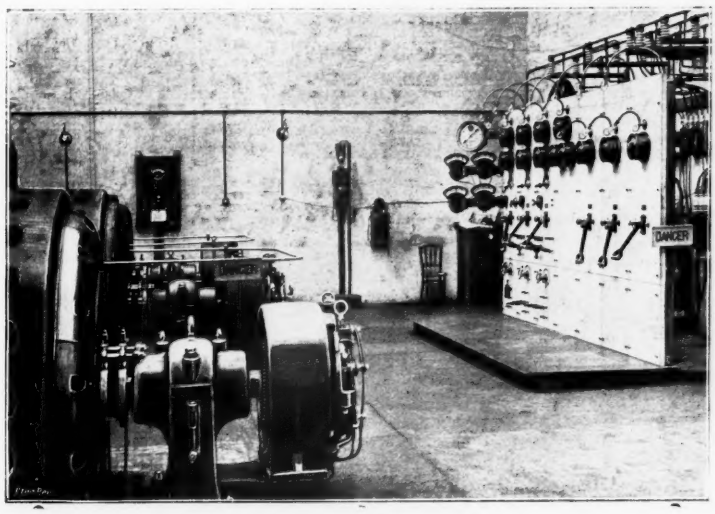
Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Beissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Vladivostock-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chefu	Mar. 9, 1904	
Swakopmund-Mossamedes (under repair)	Oct. 10, 1904	
Nassau-Jupiter Inlet	Oct. 20, 1904	Dec. 10
Paramaribo-Cayenne	July 18, 1904	
Sitka-Valdez	Nov. 11, 1904	
Landlines.		
Cartagena-Baranquilla	Dec. 8, 1900	
Puerto-Barrios	July 28, 1902	
viâ Bhamo beyond Tingyuch	Oct. 15, 1904	
Kertch-Soutehoum	Sept. 27, 1904	
Rome-Pera	Dec. 13, 1904	

The Pacific Cable Conference.—Reuter's Agency is informed that the Pacific Cable Conference, which was to have met in London at the Colonial Office last month, has been postponed owing to the fact that Sir William Mulock, Dominion Postmaster-General, the Canadian delegate to the Conference, is unable to be in England at present. So far the Canadian Government has not indicated a date on which the Dominion delegate will be able to come to London, but the Pacific Cable Board, as well as the delegates to the Conference, are anxious for the Conference to meet as soon as possible, and it is hoped that it will assemble at an early date. The delegates to the Conference appointed by the contributing Governments are:—The Secretary of State for the Colonies, president; Sir William Mulock, Canada; Sir Sandford Fleming, New Zealand; and Lord Jersey, the Australian Commonwealth. Sir Sandford Fleming, who is in Canada, has been collecting information for presentation at the Conference. Lord Massy has joined the Pacific Board as one of the representatives for Australia, in succession to Sir Horace Tozer, who has resigned his post owing to his return to Queensland.

(*Continued on page* 991.)

THE WAKEFIELD AND DISTRICT LIGHT RAILWAYS.

The West Riding of Yorkshire has during the past few years become the scene of extensive tramway developments. Not only are the larger centres of population adequately provided with extensive tramway schemes, but through the energetic action of certain well-known syndicates, the numerous smaller towns and large villages with which this manufacturing and mining district is closely studded, are being linked up and connected to the more important business centres. The district appears to be eminently fitted for developments of this character, and their larger sphere of usefulness will, no doubt, be obtained, so soon as the problem of adapting them for the carriage of suitable classes of merchandise receives a practical solution.

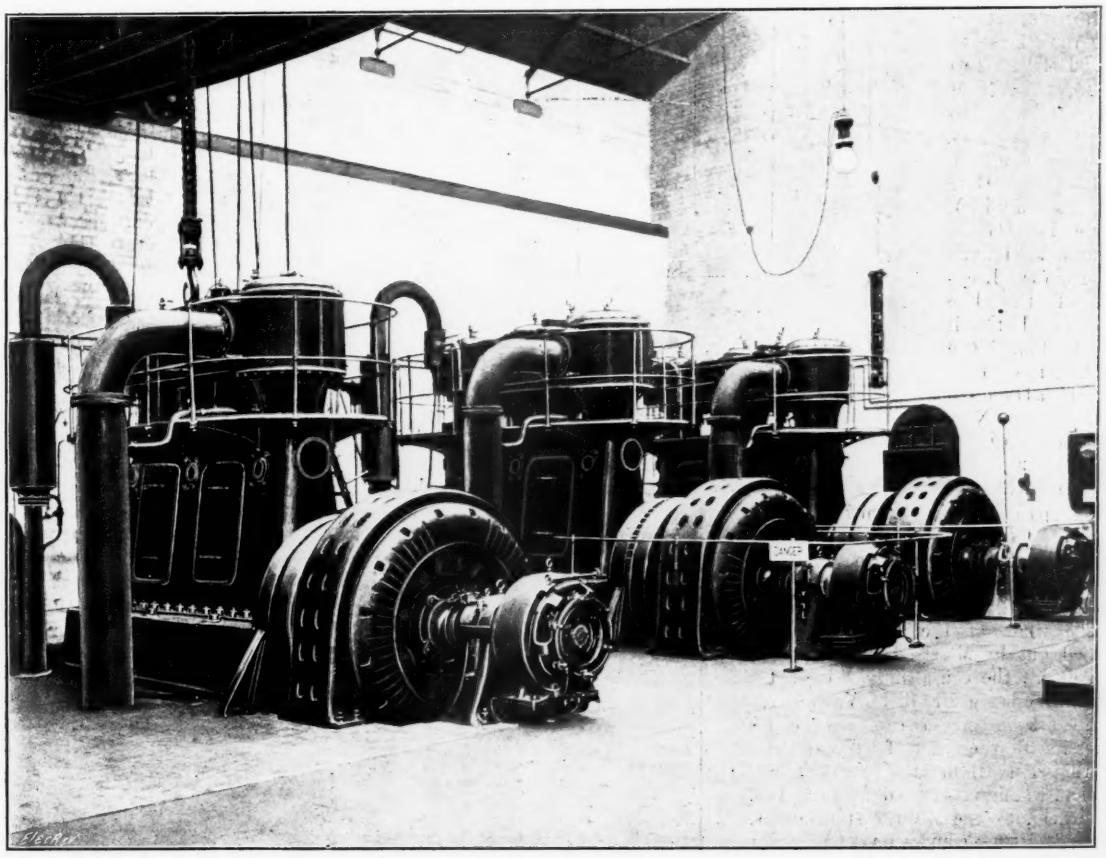


Main Switchboard at Generating Station, Belle Isle.

The present article deals with the operations of the Wakefield and District Light Railways, a comprehensive scheme which aims at providing improved travelling facilities in a wide district lying between Leeds and Wakefield, with lateral connections to Ossett, Horbury, and East Ardsley in the west, and to Normanton, Castleford, and Pontefract in the east.

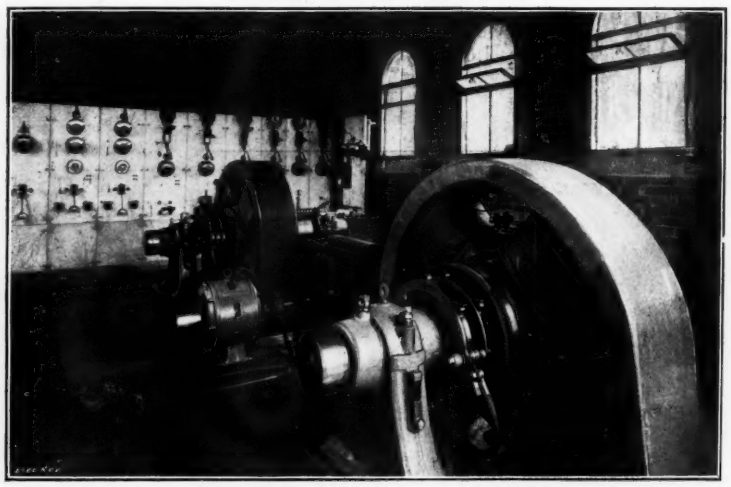
Altogether, some 75 miles of single track are projected, of which the accompanying plan (p. 990) gives some idea.

The most important route at present in operation runs from Wakefield to Thwaite Gate, where it joins up to the Leeds Corporation tramways, and it is satisfactory to be able to record that, thus early in its career, the company has been able to arrive at a mutual understanding with the Corporation as to running powers, whereby the company can run cars into the centre of Leeds.



View of Engine Room, showing Howden-Dick, Kerr 3-phase Generators.

This arrangement will, no doubt, prove exceedingly convenient to the outlying population, and should add materially to the efficiency of both systems; it was, of course, only



Rothwell Sub-station, Showing Rotaries, &c.

possible through the company having adopted the same gauge as the Leeds Corporation, which, unfortunately, is not the same as that of the Bradford and Halifax systems.

Taking Wakefield Market Place as the centre, the system branches out in four directions—to Sandal Magna (two miles), to Agbriff (two miles), to Ossett, *viâ* Horbury (nearly five miles), and to Thwaite Gate (about seven miles). There is also an important branch line from the Leeds end of the line through Rothwell and Oulton. The track has been practically completed between Normanton and Castleford, some 3½ miles, and this will be linked up to the main system in the near future. Other routes are in course of construction, and the total mileage constructed up to date is about 32½ miles of single track.

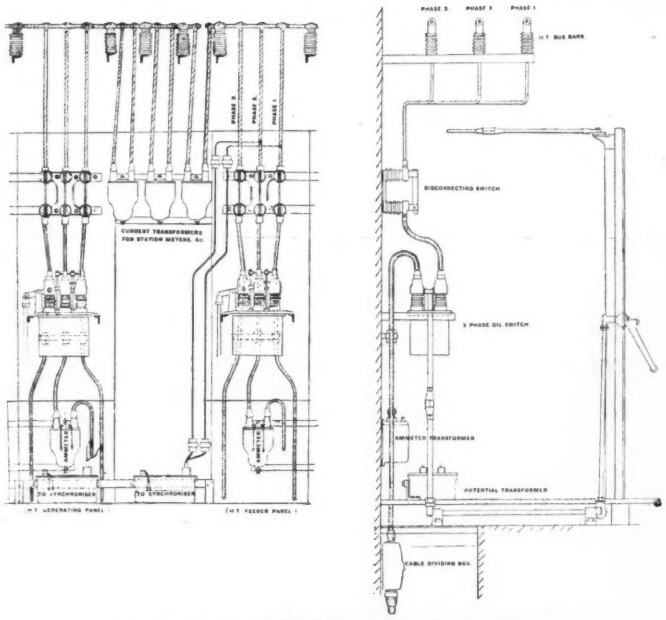
The whole of the work has been carried out by Messrs. Dick, Kerr and Co., Ltd.; the consulting engineer for the scheme being Mr. B. D. V. Cooper.

The system being an extended one, has necessitated the use of high-tension transmission from the main power station, which is situated at Belle Isle, Wakefield, to the several sub-stations, where, after conversion to direct current at 500 volts, energy is fed to the lines.

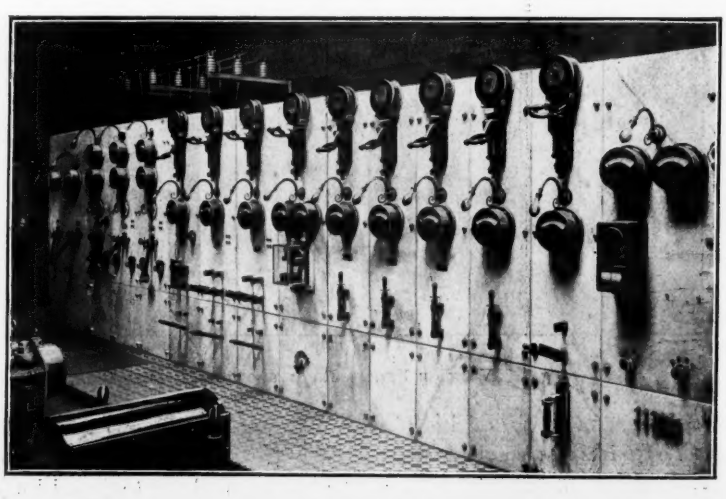
Some 25 miles of single track are now in operation, the gauge being 4 ft. 8½ in. The usual construction has been employed on about nine miles of single track, the roadway having been excavated to receive an 8-in. bed of concrete and the paving, for a width of 8 ft. for single, and 17 ft. for double track; in the latter case both the centre and margins are paved with granite setts. Some 16 miles of track, however, are laid with the roadway between the rails filled in with screened macadam. The rails are of the girder type, 6½ in. deep, with a groove 1⅛ in. wide; they weigh 94 lbs. per yard, and are laid in 45 ft. lengths, the rail joints being double bonded with 0000 Neptune copper pin bonds.

The overhead work is practically all carried out on the side-pole system, with bracket arms and flexible suspensions. The poles and bracket arms are of simple design, the former being made up in three sections of lap-welded mild steel. In residential districts a more ornamental type of bracket is fitted. The trolley wires are of hard-drawn copper wire 00 S.W.G., having a diameter of ·348 in., and a breaking strain equal to 24 tons per sq. in. At certain points the L.T. feeders are led into feeder switch pillars of the D.K. standard type, and provided with two 400-ampere quick-break switches, mounted on a marble panel. The connections to the trolley wire are of vulcanised india-rubber-covered cable.

Elsewhere, at every half-mile along the route small cast-iron boxes are fitted to the bases of the poles, each containing four 150-ampere "no-arc" switch fuses. The feeders are looped into these boxes, which serve the purpose of dividing the trolley wire into half sections and of cross-connecting for parallel running. The cable taken from these



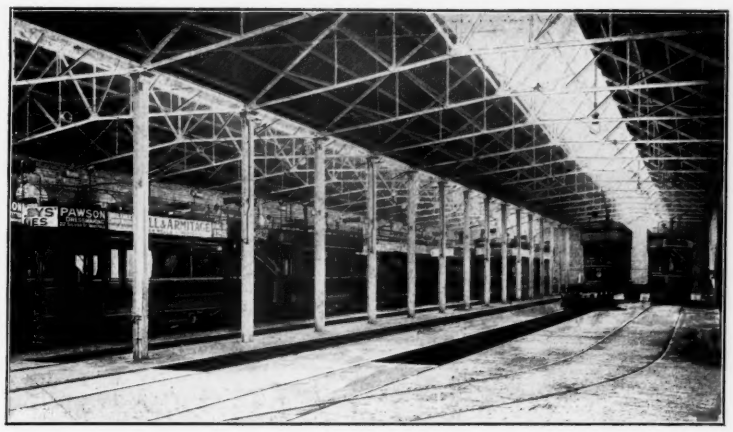
Arrangement of High-Pressure Switch Gear in Power Station.



Wakefield Sub-station: High and Low Pressure Switchboards.

connecting boxes, up the poles, has the same section of copper as the trolley wire, and is insulated with vulcanised rubber.

Three car-sheds have been constructed; the principal depôt, illustrated herewith, is situated close to the generating station at Belle Isle, and contains six tracks; it is capable of accommodating 35 cars. The other two car-sheds have been built at Rothwell and Castleford.

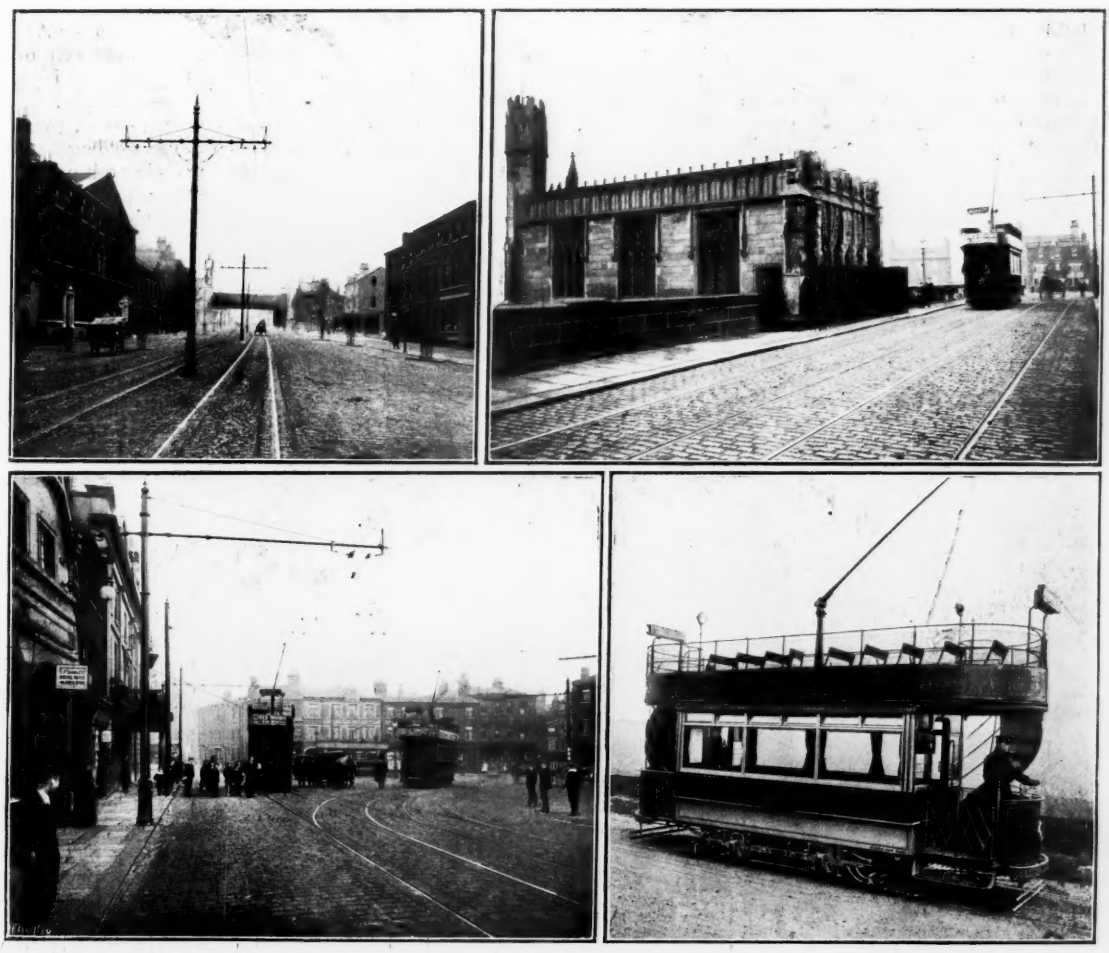


Car Sheds, Belle Isle.

The rolling stock consists of double-deck single-truck reversed staircase cars, with a seating capacity of 22 passengers inside and 34 outside. The car-bodies were built for Messrs. Dick, Kerr & Co. by the Electric Railway and Carriage Works, Ltd., of Preston. They are of up-to-date construction, and the most important parts are interchangeable.

The cars are mounted on Brill trucks of 21 E type, the motors being spring-suspended from cross-bars. The wheels are of chilled iron, and are 30 in. in diameter. A complete Dick, Kerr electrical equipment is provided, consisting of two of the firm's standard 25 A traction motors; controllers of their standard D.B.I., form C type, with metallic shield blow-out, in which one of the cylinders, on which the contact makers are mounted, controls the power and speed of the car, and the other the reversing. Either motor can be entirely cut out of service, and the car driven by the remaining one.

The power station occupies the site of an old dye works, and the steam plant consists of four Lancashire boilers, provided with fittings of normal type, together with "Lord"



(1) Centre Pole Construction, Wakefield.
(2) View on the Bridge, showing the Old Chantry.
(3) Wakefield; the Bull Ring.
(4) Typical Double-deck Car.

The cars are also fitted with life-guards of the trigger pattern.

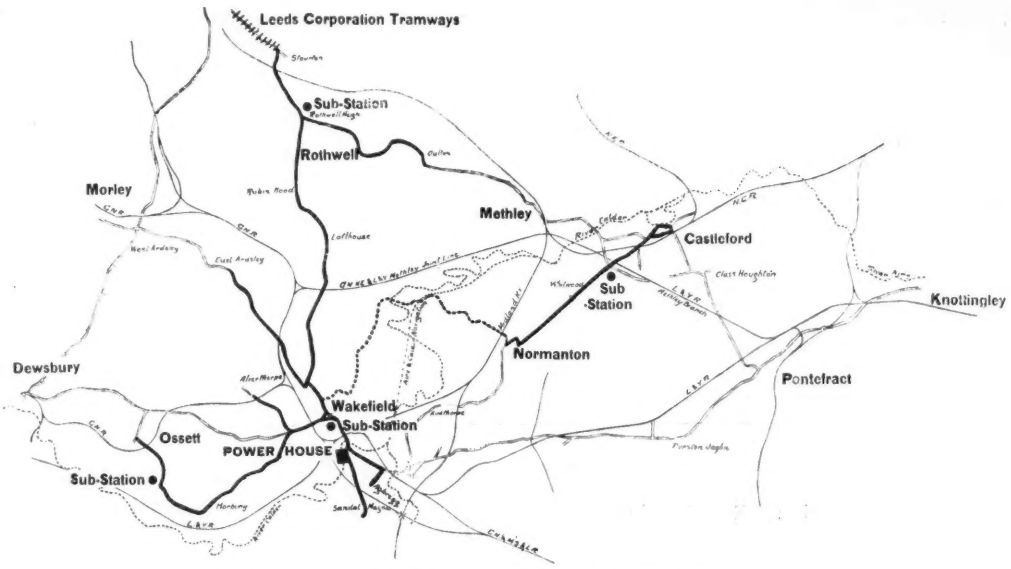
Each car is wired for 15 incandescent lamps, which are run in series of five off the main circuit, and two 16-c.p. lamps are fitted as head-lights with reflectors.

furnaces and hand-fired mechanical stokers. A Green fuel economiser, consisting of 320 tubes, with the scrapers motor-driven, is provided in the main flue; also two compound steam-driven feed pumps by Messrs. Hall, of Peterborough, capable of delivering 24,000 lbs. of water per hour against

a boiler pressure of 150 lbs. The feed water is drawn from the River Calder, or the town supply. In the boiler house is situated a small Willans D.C. generating set, which is used for driving the motor-driven auxiliary plant.

In the engine room (p. 987) are three "Howden" high-speed triple-expansion engines, rated at 600 B.H.P. on normal, and 750 B.H.P. on overload, working at a steam pressure of 150 lbs. per sq. in., and running at 375 r.p.m.; these are direct coupled to Dick, Kerr's standard three-phase alternators, generating at 6,300 volts, 25 cycles, each set being provided with a direct-driven exciter. The engines are condensing, each being provided with a "Körting" ejector condenser, designed to give a vacuum of 24 in., when dealing with 12,000 lbs. of steam per hour.

The water for condensing purposes is drawn wholly from the River Calder; three 6-in. motor-driven "Invincible" centrifugal pumps, running at a speed of 1,000 r.p.m., and capable of lifting 550 gallons of water per minute, are installed in a pump house, over which is situated a storage tank of 20,000 gallons capacity. The alternators are "star" connected, have an output of 400 KW. continuously, and are designed to give an overload of 25 per cent. for one hour, with a moderate rise of temperature. All three machines are designed to run in parallel with each other, means being provided for raising their voltage up to 6,600 to compensate for loss in the mains when running at a constant speed. The rotor spider is made of cast-iron, the hub being provided with a flange for bolting to the engine fly-wheel, and is pressed on to the shaft and key seated.



PLAN OF THE WAKEFIELD AND DISTRICT LIGHT RAILWAYS.

The pole-pieces are made of laminated steel, the upper parts being of T-shape construction for holding the field coils in position, and the lower parts dovetailed for fixing on the rim of the rotor. The removal of the field coils is effected by sliding the pole-piece from the dovetailed groove parallel to the shaft, without disturbing any other part of the machine. The machines are designed to give approximately sinusoidal waves of E.M.F. The stator frame is of cast-iron, built in halves, and is designed to allow complete ventilation of the laminations.

The stator coils are former wound, and are embedded in rectangular slots, being held in position by wooden wedges.

The exciters are 14 KW. four-pole shunt-wound machines, with the armature built up on the end of the main shaft, and giving a pressure of 140 volts.

VIEW ON LEEDS—WAKEFIELD ROUTE.

The switchboard was built by Messrs. Dick, Kerr & Co., and consists of seven enamelled slate panels, each supported independently on an iron frame. The board, which consists of three generator panels, one power panel and three H.T. feeder panels, is shown on p. 987.

The engine room is spanned by a 12-ton hand-power travelling crane worked from the floor level; this was supplied by Messrs. Jessop & Appleby.

The existing sub-stations are situated at Wakefield and Rothwell, and others are to be provided at Castleford and Osset.

The sub-stations are fed from the power station by duplicate three-core H.T. lead-covered cables. At the Wakefield sub-station, situated about a mile from the power station, there are three standard Dick, Kerr 200-KW. compound-wound rotary converters, running at 750 r.p.m., generating direct current at 500—550 volts. Each rotary has its complement of single-phase, oil-cooled, step-down transformers. The rotaries are capable of dealing with an overload of 25 per cent. for one hour. The Rothwell sub-station is similar to the one at Wakefield, but is equipped with two rotaries, with the necessary transformers and switchgear.

The sub-stations are each equipped with suitable travelling cranes, and a small induction motor of standard type with squirrel cage rotor is provided for starting up the rotaries by means of a belt drive.

Our illustrations on p. 988 show the general outlines of the plant installed in the sub-stations.

The scheme appears to have been carried through in a workmanlike and practical manner, there being a complete absence of that superfluous detail with which so many undertakings are unduly weighted in their early years.

TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 986.)

Bournemouth Telephones.—After applying for a telephone licence the Corporation, as a result of a lengthy debate on December 7th, has resolved, by 17 votes to 14, to abandon the scheme and discharge the Telephone Committee.

Wireless Telegraphy.—The *Times* says that the new wireless telegraph coast stations erected by the Marconi Co. to the order of the Canadian Government were put to considerable use for the exchange of messages on the Earl of Minto's departure from Canada. The *Tunisian*, of the Allan Line, in which Lord Minto sailed, was in communication with the Fame Point Marconi station for 10 hours, and with the Cape Race Marconi station for 150 miles.

The mail steamer *Campania*, which arrived at Queenstown from New York last week, reports that during the quick voyage of five days 18 hours, wireless communication was established with no fewer than 12 trans-Atlantic liners, ten of which were bound to American ports and two to British ports. Messages were received from and sent to each of these boats. When the *Campania* was 1,200 miles from New York, wireless communication was established with the Cunard steamers, *Saxonia* and *Ivernia*, the former from Liverpool to Boston, and the latter from Boston to Liverpool. The three Cunarders continued in communication at the same time for several hours, all the latest news from England and America being sent by the *Campania* to the Boston steamers.—*Daily News.*

Mr. Shaw, Secretary to the Treasury, in his annual report on the Finances of the United States, stated under the heading of "Revenue Cutter Service" that preparations were being made, through another department, for the erection of wireless telegraph towers along the sea coast, and that these, in connection with those belonging to private corporations, would afford opportunity for the advantageous use of wireless telegraphy by this service. He also recommended that at least ten of the modern vessels forming the coastguard should be equipped with approved wireless equipment, the estimated cost of this being estimated at $19,000 (£3,800).

The cable between Penzance and the Scilly Islands being interrupted, the Post Office announced on Tuesday that the telegraphic service with Scilly would that day, and until further notice, be restored by wireless telegraphy *vid* Falmouth and the Lizard Station. The charges are not affected.

CONTRACTS OPEN AND CLOSED.

OPEN.

Cardiff.—December 19th. Two low-speed vertical engines and 1,100-KW. three-phase alternators; four Lancashire boilers, piping, switchboard gallery, three-phase cables, &c., for the Corporation. See "Official Notices" December 2nd.

Glasgow.—December 22nd. The Corporation is inviting tenders for the supply of 100 electric car motor equipments and spare parts for the same. Specification on application to Mr. James Dalrymple, general manager, 102, Renfield Street, Glasgow.

Great Western Railway.—January 3rd. Conductor rails, insulating supports, copper bonds, &c., for the electrical equipment of the Hammersmith and City Railway. See "Official Notices" December 9th.

Johannesburg.—December 27th. Transformer pillars and switchgear; also two 35-ton electric overhead travelling cranes, for the Municipal Council's electrical undertaking. See two "Official Notices" October 28th.

Manchester Ship Canal.—December 22nd. Switchboards, mains, feeders, arc lamps, &c., for the new dock works at Salford. See "Official Notices" December 2nd.

Middlesbrough.—December 17th. Pipe-work and valves for the Electricity Committee. See "Official Notices" December 2nd.

Neath.—December 28th. Alternating current watt-meters for the Corporation. See "Official Notices" to-day.

Port Elizabeth.—January 16th. Water-tube boilers, 400-KW. turbo-dynamos, mains, battery and boosters, switchboard, crane, public lighting, meters, workshop equipments and other plant, &c., for the Electricity Supply Undertaking. See "Official Notices" to-day.

Pudsey.—January 20th. Underground mains, junction boxes, switchboard, &c., for the Corporation. See "Official Notices" to-day.

Rochdale.—December 27th. Three-phase and continuous-current switchgear, for electricity works extensions. See "Official Notices" December 9th.

Roumania.—January 28th, 1905. Tenders are being invited by the municipal authorities of Guirgin for the concession for the electric lighting of the town.

Shanghai.—March 31st, 1905. Construction and working of 24 miles of electric tramways on the trolley system, double or single. See "Official Notices" October 14th.

Southend-on-Sea.—December 21st. Two boilers, steam dynamo, fuel economiser and two electrical feed-pumps, for the Corporation. See "Official Notices" December 2nd.

Spain.—December 22nd. The Municipal Authorities of Almendralejo (province of Badajoz) are inviting tenders until the 22nd inst. for the concession for the electric lighting of the town during a period of 10 years. Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Almendralejo (Badajoz).

Spain.—December 26th. The Municipal Authorities of Valladolid are inviting tenders until the 26th inst. for the concession for the electric lighting of the town during a period of six years. Tenders are to be sent to El Secretario del Ayuntamiento, Maison Consistoriale, Valladolid, whence particulars may be obtained.

Spain.—December 24th. The *Gaceta de Madrid* of November 24th contains a notice calling for tenders for the public lighting by electricity of Villanueva y Geltru for a term of 10 years. For particulars see above paper.

Spain.—January 10th. The Spanish Ministry of Public Works in Madrid is inviting tenders until January 10th for the construction and working during a period of 60 years of an electric tramway between Azcoitia and Zumaya (province of Guipuzcoa). Particulars may be obtained from, and tenders are to be sent to, La Direccion General de Obras Publicas, Madrid.

Sunderland.—December 30th. Wooden cooling towers for the Electricity Department. See "Official Notices" to-day.

Swindon.—December 20th. One 300-KW. or 400-KW. steam dynamo, for the Corporation. See "Official Notices" December 2nd.

West Ham.—Fan engine and "Sirocco" fan, steel chimney, condenser, tanks, hot well, and piping for the electricity department. See "Official Notices" December 2nd.

CLOSED.

Bannockburn Collieries.—The British Electric Plant Co., Ltd., have been awarded by the Alloa Coal Co. the contract for a complete electric power plant on the direct-current system for their Bannockburn Collieries, together with engines for the same.

Blackpool.—The T.C. has accepted tenders as follows:—

Walter Scott, Ltd., for the supply of tram-rails, fish-plates, and anchor joints for the new promenade tramway.
Guest, Keen & Nettlefold, Ltd., for tie-bars.
Edgar Allen & Co., Ltd., for points, connecting boxes, crossings, manganese steel rails, and drain boxes.
Bayliss, Jones & Bayliss, Ltd., for bolts, nuts and washers.
Percy Dewhirst for the erection of a switchboard at the refuse destructor works.

Canterbury.—The T.C. has accepted the tender of the Reason Manufacturing Co., Ltd., for the supply of meters for one year, and that of Mr. J. S. Dadd for extensions at the Electricity Works, at £358 16s.

Deptford.—The tender of the Hart Accumulator Co., Ltd., has been accepted by the Borough Council for additions and alterations to the existing battery installed at the Public Baths, New Cross, S.E.

East Ham.—The B.C. has placed an order with Messrs. Dick, Kerr & Co., for top covers for 10 electric tramway cars, at £85 each.

Hammersmith.—An order has been placed with the Imperial Engineering Supplies Co., Ltd., for pavement ventilated frames and covers of Sowden's patent type.

Liverpool.—The City Council has, on the Electric Power and Lighting Committee's recommendation, accepted the tender of the Westinghouse Co. for two steam turbo-alternators, at £8,035 per set; of Green & Son, Ltd., for one economiser, £657; of Babcock and Wilcox, for four boilers, stokers, and superheaters, at £7,200; and of the Wheeler Condensing and Engineering Co. for condensing plant, at £13,400. These are repeat orders, and tenders were not invited.

Salford.—The T.C. has accepted the following tenders for the Electricity and Tramway Departments:—

Wm. Smith & Co., Ltd., Salford, ironmongery (electricity works).
Sturtevant Engineering Co., Ltd., large motor starters.
Veritys, Ltd., double-pole main switches.
Electromotors, Ltd., electric motors, ½ to 8 H.P.
Chamberlain & Hookham, Ltd., motor-meters, 25 to 100 amperes.
General Electric Co., Ltd., steel insulated screwed tubing, electric fittings, &c.
Hartcliffe, Lee & Malkin, Ltd., brass and gun metal castings.
Lancashire Dynamo and Motor Co., Ltd., electric motors, 5 to 80 H.P.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Electricity and Tramway Board has accepted the tender of Messrs. Underwood & Brother for joining the Board's tramways with those of Ashton-under-Lyne T.C; that of Messrs. Dick, Kerr and Co., Ltd., for the overhead equipment; and that of Messrs. Cook & Son for the supply of heating apparatus for the car-shed stores and fitting shops.

Whitby.—The U.D.C. has been recommended to accept the following tenders:—

Boiler, pipework and mechanical stoker, Babcock & Wilcox, £945.
Engine and dynamo, Parsons & Co., £1,550.

Woolwich.—The B.C. has accepted the tender of Callender's Cable & Construction Co., Ltd., for the supply of high-tension mains, at £8,493. W. T. Henley's Telegraph Works Co., Ltd., tendered at £8,575.

FORTHCOMING EVENTS.

Friday, December 16th.—At 7.30 p.m. Institution of Electrical Engineers (Manchester). Mr. E. D. S. Shelmerdine on "The Working of Batteries Under Reversible Booster Control."

At 7.30 p.m. North-East Coast Institution of Engineers and Shipbuilders. Ballot for new members. Resumed discussion on Mr. W. R. Cummins's paper, "A Comparison of Vertical and Horizontal Tubes in Water-tube Boilers."

Saturday, December 17th.—At 7.30 p.m. Glasgow Technical College Scientific Society. Thirteenth Anniversary Dinner.

Monday, December 19th.—At 8 p.m. Faraday Society. The following papers will be read:—"The Electric Furnace: Its Origin, Transformation, and Applications" (Part II.), by Mr. Adolphe Minet; "Electrolytic Analysis of Cobalt and Nickel," by Messrs. F. M. Perkin and W. C. Prebble; "The Electrolytic Preparation of Tin Paste," by Mr. F. Gelstharp; "Note on the Electrolytic Recovery of Tin," by Mr. F. Gelstharp.

THE ELECTRICAL VOLUNTEERS.

The following orders are issued for next week:—

Monday, December 19th.—"A" Company: Recruits' drill, 6 p.m. Technical instruction, 7 p.m.
Tuesday, December 20th.—"B" Company: Recruits' drill, 6 p.m. Technical instruction, 7 p.m. Medical inspection for recruits and Special Service Section, 7 p.m.
Wednesday, December 21st.—Submarine mining class, 6—9 p.m.
Thursday, December 22nd.—"C" Company: Recruits' drill, 6 p.m. Technical instruction, 7 p.m.
Friday, December 23rd.—"D" Company. Recruits' drill, 6 p.m. Technical instruction, 7 p.m.
Saturday, December 24th.—Headquarters closed for Christmas Holidays until January 2nd, 1905, inclusive.

Wilfred C. Dumble, Capt. R.E.
For O.C.E.E.R.E. (V.)

NOTES.

Our Xmas Week Issue (December 30th).—We wish to advise our friends in good time of the arrangements which are necessitated in our editorial and advertisement departments in consequence of the Electrical Review offices being closed on Monday, December 26th, and Tuesday, the 27th, for the Christmas holidays.

Editorial correspondence and articles should reach us on Saturday, December 24th, as far as possible, but the usual arrangements will prevail with regard to late news matter.

Alterations to existing displayed advertisements, and new copy, should be in the hands of the advertisement department not later than Friday morning, December 23rd. Official announcements and small prepaid advertisements will, however, be in time if they arrive by Thursday, December 29th, at noon.

The Electrical Engineers R.E.V.—The annual dinner of the Non-Commissioned Officers' Mess was held on Saturday, December 10th, at Anderton's Hotel. About 75 sat down to dinner. Comp.-Sergt.-Major Marshall, president of the Mess, occupied the chair, supported by Major Dumbell, adjutant, Capts. O'Shaughnessy, Leaf and Rossignol, Lieuts. Shepherd and Humphreys, Surgeon-Capt. Martin, Surgeon-Lieut. Leaf, Major Kemp, and N.C.O.'s from the Royal Engineers and Royal Garrison Artillery. The usual loyal toasts were duly honoured, and Major Dumbell, replying for the staff, made what was undoubtedly the speech of the evening. After referring to the *camaraderie* existing in the corps, he proceeded to illustrate by apt metaphors the position of the staff in relation to the N.C.O.'s and men to fill respectively the offices of driving belt, split pin, lubricating oil and explosive mixture by which the motive power was supplied. An excellent variety entertainment was provided, and the general spirit of comradeship evinced on all sides made the gathering most successful.

Alternating-Current Traction from Gas Power.—The Warren and Jamestown Street Railway Co. is equipping a single-phase electric railway system to operate between Warren, Pa., and Jamestown, N.Y., for which power will be supplied by gas engines operating upon natural gas. The equipment, according to the New York *Electrical World and Engineer*, is now being constructed by the Westinghouse Cos. at East Pittsburg, Pa.

The power station will be located at Stoneham, Pa., two miles from Warren. The initial equipment will consist of two Westinghouse gas engines, each of 500 H.P. capacity. They will be of the horizontal, single crank, double acting type, direct connected to two 260-KW. Westinghouse generators furnishing current at a voltage sufficient for direct use upon the high-tension transmission line. The power equipment also comprises a 55-H.P. gas engine for operating air compressor and exciter units. Natural gas will be furnished by the local distributing company. In this district the gas has a calorific value of 1,000 B.Th.U. per cb. ft. Transformer sub-stations, five in number, will be located along the right of way. These will receive the high-tension current from the transmission line and reduce the voltage to such an extent as to render it more suitable for use in single-phase motors. The present motive power equipment will comprise four quadruple sets of single-phase motors, each of approximately 50-H.P. capacity. An interesting feature of the system is the arrangement for operating the alternating current motors upon the direct current trolley lines within the city limits at the termini. The Warren and Jamestown Street Railway is not a newly organised system, as it has operated part of the present lines for a period of 11 years. Three years ago the company began experimenting with the use of gas power, with sufficient success to influence it in the now exclusive adoption of gas engines for its entire power generation.

The London Traffic Commission.—The *St. James's Gazette* says that the greater part of the London Traffic Commission's report is in type. It will be issued before the reassembling of Parliament in time, it is hoped, to enable the Government to adopt, if it approves them, some of the recommendations in dealing with the many schemes which are set down for consideration in the ensuing session. The Commissioners are said to be unanimous in proposing the establishment of an expert tribunal which will examine every scheme requiring Parliamentary sanction, and give advice. It is generally anticipated that the recommendation will be accepted by the Government, and that it will be speedily given effect to in order that the Bills now deposited may go before the new authority. Some very important suggestions have been made by the Technical Advisory Committee to the Royal Commission in connection with the many schemes which the Commission asked the Committee to consider and report upon. A number of the schemes were found to be inadvisable, and a few impracticable, but several of them, with alterations, have been recommended for acceptance. Emphasis, it is believed, is laid on the necessity for more uniformity and greater homogeneity. Valuable expressions of opinion are expected on the question of the suitability of the "tubes" and shallow tramways for London, and a number of suggestions will be made with regard to the provision of alternative main roads and the control of road traffic generally.

Appointments Vacant.—Lecturer and demonstrator in electrical engineering for the Woolwich Polytechnic (£150); publicity department manager for the Croydon electricity works (£150); car-shed superintendent for Blackburn Corporation Tramways department (50s.). The Newcastle-upon-Tyne Corporation is inviting applications for the appointment of tramways manager at £700.

Condensers for Steam Turbines.—Mr. George B. Rockwood has contributed some notes on the above subject to the American Society of Mechanical Engineers. He estimates the cost of condensing plant at 30s. to 40s. per kilowatt with the different systems of plant.—(*a*) Surface condenser, a centrifugal hot well pump, an air cooler, a single cylinder dry vacuum pump, and a centrifugal circulating pump complete; (*b*) the same, but a wet vacuum pump, omitting air cooler, dry pump and hot well pump. The third usual system is the barometric, which takes less space, costs 20s. to 25s. per kilowatt, but does not provide clean water for the boilers. A fourth class is specially pointed out in the paper, viz., the ejector condenser. At the Atlantic Mills a vacuum of 28 to 28½ in. is maintained on a turbine by the following system:—The exhaust is taken to a Bulkeley ejector condenser 34 ft. above ground level, the turbine being 12 ft. 6 in. above ground. Water comes 500 ft. from a river under a head of about 3 ft., and it is elevated by a centrifugal pump to a vertical tank 15 ft. deep, maintained 6 in. below the water inlet of the condenser. The depth of the tank serves to separate air pumped up with the water, which is drawn off to the condenser by a 7-in. pipe near the tank bottom. The 28½ vacuum extends to the exhaust part of the turbine, the exhaust pipe being 16 in. diameter from a 400-KW. turbine. With a 300 to 350-KW. load the hot well is 80° to 90° F. It is not found at all satisfactory to have the injection pipe approach the condenser horizontally. The centrifugal pump to supply water to the condenser requires 10 H.P. for 400 KW. output. The ejector condenser complete costs 8s. to 10s. per kilowatt, or less if there is a natural head of water. It appears that with water at 7 cents per 1,000 gallons (4½d. per 1,000 English), it would cost annually about £44 for 400 KW., so that with 5 per cent. interest and 8 per cent. fixed charges, a capital expenditure of £334 alone is warranted, and it may easily not pay to buy surface condensers to avoid paying for feed water. In English cities water costs usually more than the above, and an artesian supply is often worth securing, for water can be pumped for ½d. per 1,000 gallons. The author is by no means enamoured of perfectly pure water which will, he says, pit the tubes and water legs of the boilers. The Atlantic Mills are believed to be the only instance where such a type of condenser is in use for turbines.

Motor Traffic.—Mr. C. S. Rolls, in a lecture last week at the London Institution on the present condition and future possibilities of motor traffic, said that since the passage of the Light Locomotives Act, 1896, the manufacture of motor-cars in Great Britain had shown remarkable growth. There were now at least 130 makers, but the trade did not yet equal that of France, where the industry employed 200,000 men, and last year's exports amounted to about £1,000,000. England, however, produced more cars for heavy traffic. Last year 6,133 light vehicles were imported, as against 3,747 in 1904, and the value of cars and parts imported during the year amounted to nearly £2,000,000. For long distances goods would be sent by railway, but for shorter distances, owing to terminal charges, conveyance by motor lorries would be cheaper. Steam was recommended for heavy haulage, the petrol motor for light vehicles, and electricity as a luxury for town use.

Papers and Lectures.—At the last meeting of the Leeds University Engineering Society, Mr. C. E. Stromeyer, in a highly technical paper, discussed "The difficulty of attaining maximum efficiency of boilers without injuring them." He remarked that it was easy to state the problem in its simplest form, but it grew more and more difficult when practical experiences were called in for assistance. When complete combustion is obtained with only the requisite air admission the heat of the boiler furnace is sufficient to melt osmium, and with twice that quantity of air a temperature of 2,527° F. is obtained. These high temperatures are reduced in practice by using about twice the theoretical amount of air, which is heated initially before entering the furnace. The lecturer examined the question of the effects of high temperatures on boiler working, the leakage of water tubes, and the distortion of tubes and plates. In conclusion, he said it was highly desirable to ascertain if boiler troubles and mishaps were inseparately associated with high furnace temperatures due to minimum air admission, or whether these bad effects were due to sediment, grease, scale, &c. He suggested that possibly some impurity could be added to the water so as to give a stronger cooling effect on the boiler plates than at present. A discussion followed the lecture, and Mr. Stromeyer was accorded a hearty vote of thanks.

At a meeting of the Glasgow University Physical Society held on Wednesday, 7th inst., Dr. C. E. Fawsitt read a paper on "Electrical Methods in Chemical Investigations." The paper evoked a considerable amount of discussion.

Prof. S. P. Thompson lectured on "Michael Faraday and the Modern Development of Electricity" before the Cardiff Naturalists Society on December 8th.

At the meeting of the Institution of Electrical Engineers (Glasgow Section) on Tuesday night, a paper by Dr. James B. Henderson and John S. Nicholson, of the James Watt Laboratory of the University, was read on "Armature Reaction in Alternators."

Among the papers down for reading before the Royal Society yesterday, was one by Dr. C. H. Lees on "Effects of Temperature and Pressure on the Thermal Conductivities of Solids. Part I. The Effect of Temperature on the Thermal Conductivities of some Electrical Insulators." Communicated by Prof. A. Schuster, F.R.S.

Yarmouth Tramrails.—The Yarmouth Town Council has, by a large majority, ordered 800 to 900 tons of steel rails from Belgium for the electric tramway system. The Belgian price is 95s. per ton, as compared with 104s. 6d., the lowest English tender.

Northampton Institute.—The annual prize distribution and students' conversazione took place on Friday last, and, as usual, there were very large gatherings. Dr. R. Mullineux Walmsley reported upon the work done during the session, and again commented upon the necessity for greater accommodation. The prizes and certificates were subsequently distributed by Lord Reay, who, in the course of his address, congratulated the principal and others upon the work that had been done, and referred among other things to the lack of apprenticeship openings in London, which meant that boys who wished to become apprentices had to go to the provinces. There ought to be some remedy for this. The conversazione was continued on Saturday. One of the items in Friday's programme was a lecturette on "Electric Lighting: Past, Present and Future," by Dr. C. V. Drysdale. In the same room there was also a lecturette on "Alternate Current Experiments."

British Electrical Friendly Society.—The third annual meeting of this society was held on Monday at Essex Hall, Strand, Mr. W. G. A. Bond presiding. The report stated that at the close of the financial year there were 1,950 members on the books, and the receipts from all branches amounted to £3,574. Of this sum the companies' contributions aggregated £1,043. During the year 693 members claimed sick pay, amounting to £2,044. The increase of £199 as compared with the sick pay in 1903, was mainly attributable to accidents. There were now 29 branches at work, and the actual strength of membership in individual branches had been as a whole well maintained. The chairman moved the adoption of the report, which was seconded by Mr. Garcke and carried unanimously. Revised rules, intended to meet the altered conditions consequent on the institution of a pension fund, were afterwards discussed and approved.

London County Council.—At the meeting on Tuesday, the Highways Committee reminded the Council of the acceptance in November, 1901, of the tenders of Messrs. Dick, Kerr & Co. for the supply of continuous current plant and three-phase plant respectively. The engines in connection with the former had been installed at the Loughborough station, and those in relation to the three-phase plant at the Deptford station. Under the terms of the specifications for the engines delivered under each order, the contractors were entitled to a bonus at the rate of £300 per lb. for every lb. or fraction of a lb. by which the steam consumption of each engine fell short of 24 lbs. per KW.-hour. A series of tests had been made with a view to ascertaining the steam consumption, with the result that the actual consumption was found to be 22·35 lbs. per KW-hour at full-load. This corresponded to a reduction of 1·65 lbs. per KW.-hour on the guarantees required by the specification, and the contractors were accordingly entitled to a bonus of £495 on each of the four engines, making a total of £1,980. The reduction in the steam consumption would effect a considerable saving in coal, and the Committee asked the Council to approve the expenditure, the amount of which would probably be saved in steam consumption during the first year of the working of the engines by the Council.

The Highways Committee stated that 51, out of the 61 roof-covers sanctioned some months ago, had been ordered from Milnes, Voss and Co., of Birkenhead, while the remaining 10 had been put in hand at the Council's own car works. Some of the roof-covers had already been fixed and were in use, and the result was to be found in an increase in the traffic receipts of the cars so fitted. The Council postponed for a week the consideration of a recommendation in favour of expending £8,500 on the provision of 100 additional roof-covers of the Mengarini type, and to be constructed by the Council on payment of a royalty of £4 10s. per roof-cover to the before-mentioned Birkenhead company.

The London Electric Lighting Areas Act, which was promoted by the Board of Trade, was also referred to by the Highways Committee, which recalled the fact that the Council sought to obtain an amendment for the protection of transferred consumers. This endeavour was, however, unsuccessful, although the Board of Trade undertook, before any agreement entered into under the Act was confirmed, to give the Council an opportunity of considering the matter.

To Electrical Exhibitors.—The Metropolitan Electric Supply Co. is organising an electric appliances exhibition, to be held from March 27th to April 1st next at Paddington. Firms who propose exhibiting are invited to communicate with the company.

South African Notes.—*Johannesburg.*—Our Durban correspondent informs us that a scheme of great importance to Johannesburg and the Reef will be submitted to the Inter-Colonial Council during the session which has just opened at Bloemfontein. The scheme referred to is a draft agreement between the Railway Administration and Messrs. Mordey & Dawbarn for the electrification of the Springs to Randfontein section of the Central South African Railways, a distance of 57 miles. The scheme in view contemplates the erection of a power station at Germiston, which will be a convenient centre in view of similarly equipping the Pretoria branch, distributing by means of overhead mains for the supply of three-phase current along the route. It is satisfactory to note that British material is being strongly recommended.

Kimberley.—Presiding at the sixteenth annual meeting of De Beers, Sir Lewis Michell said a large electric power station had been completed to light the town, and the electric train to Alexandersfontein was in course of completion.

Kingwilliam's Town.—On November 15th, after a lengthy discussion, the B.C. unanimously decided to take over all the assets and liabilities of the King Electric Lighting Co., according to an

agreement drawn up when the company was formed, and also to call for any objections to this action from the burgesses. The Mayor explained that the Council only possessed the right to take over the undertaking until 1907; after that period expired, unless a bargain with the company was come to, it would have to take a supply for public lighting for 25 years. All assets and liabilities had to be taken over as they stood. The average monthly revenue of the undertaking at the above date was over £400, and the total value of the plant was estimated at £21,000. Supply of electricity to the town has been available since October 23rd, 1903.

Gas Accidents.—One of the most serious gas explosions in this country that has been recorded of late occurred on Wednesday at a drapery establishment in Southampton Row, W.C. Much damage was done to the premises, and a dozen people were injured. An escape of gas occurred during the fitting of a new service pipe in the basement, and it is thought that someone in passing dropped a glowing match which caused the explosion.

The fumes given off by a gas stove rendered a Southport man and his wife unconscious. The latter, who was suffering from asthma, recovered, but her husband did not. An inquest was held on Wednesday.

Metallic Carbides as Metallurgical Reagents.—A process has been devised by Mr. H. S. Blackmore, of Mount Vernon, U.S.A., for utilising in a manner more perfect than heretofore possible, the mutual reaction which occurs between metallic carbides and metallic oxides, the fundamental idea being that the reaction shall occur within the body of a flux. This, it is claimed, causes the reaction to be more complete, and enables it to be carried out at a temperature lying below the melting point of the oxide employed. As an example, a mixture of four parts by weight of cryolite and one part of lithium fluoride is melted; and into the bath are introduced alternately aluminium oxide and equivalent quantities of aluminium carbide. These latter continuously react to yield free aluminium, which is removed at intervals from the bottom of the vessel, while the igneous solvent remains fit for further service. Potassium fluoride makes the bath more fluid, but lithium fluoride has the advantage of conferring upon it a lower specific gravity, so that the metal sinks better. If some oxide other than that of aluminium is employed, *e.g.*, copper, an alloy of aluminium with that other metal is produced. By adding calcium carbide in place of aluminium carbide to the cryolite bath, the aluminium fluoride in the latter is gradually decomposed and converted into carbide, which then reduces any metallic oxide present; and when the whole of the aluminium fluoride is destroyed, an alloy of aluminium and calcium may be formed by the action of the surplus calcium carbide upon aluminium oxide. The calcium may be removed from this alloy by adding further quantities of cryolite to the bath. The process is capable of numerous modifications, but can only be carried out with metallic carbides. Carbides of non-metallic elements treated similarly give compounds of the metal employed with the non-metallic element, and not free metals or alloys.

A Carbon (or Gas) Battery.—"A revolutionary process of generating electric power, destined to supplant steam," or, in other words, a new "carbon" cell, entitled the "Dynelectron," has been described by an American paper as the invention of a Mr. J. H. Reid. So far as we can understand the account given of this apparatus, it consists essentially of the usual carbon caustic soda iron arrangement, with which the name of Jacques was identified some years ago. The dynelectron is a cast-iron cell 16 × 16 × 26 in. in size, charged with a solution of caustic soda containing 1·5 per cent. of iron oxide, in which are a large number of hollow carbon rods. The apparatus has to be kept at a temperature of between 350° and 400° F., to be supplied with air at a pressure of 10 or 12 lbs., and to have the loss of water which occurs made good. In these conditions the element is said to yield current having an E.M.F. of 0·9 volt on open circuit; or, on closed circuit through a resistance which allows 200 amperes to pass, a voltage of 0·7 or 0·8. Also it is stated that one cell of the size mentioned will yield power equal to 1 E.H.P. The electrodes are not destroyed, nor the electrolyte, as the current is produced by the "hydration and dehydration" of the caustic soda. By a somewhat curious coincidence, just at the time when this interesting report was published, a paper by F. Haber and L. Bruner appeared in the *Zeitschrift für Elektrochemie* on the subject of the carbon cell; the authors remark that although the Jacques battery was thoroughly criticised at the time of its exploitation, the precise chemical changes occurring in it have never been investigated. They find that iron becomes passive in molten caustic soda owing to a coating of oxide. Passive iron and bare platinum make good oxygen electrodes in fused soda, provided the latter contains manganese. Most caustic soda does contain manganese, and all common iron does so, so that sodium manganate is formed in the melt. The oxygen potential becomes greater as the temperature rises. Active iron and attackable carbon form hydrogen electrodes in molten caustic soda, their potential being that of the gas. As it is conceivable that carbon monoxide might be produced by local action from the carbon and atmospheric oxygen, and that this might give sodium formate (which should be the cause of the E.M.F.) by reacting with the hydroxide, the authors have experimentally established the fact that a formate, or an oxalate, is immediately decomposed in a caustic alkali into alkali carbonate and hydrogen; while, in presence of excess of fused caustic, carbon monoxide yields carbonate and hydrogen also. The hydrogen, therefore, is the sole cause of the electromotive force. Hence the so-called carbon cell is a gas battery, the oxygen coming from the air, and the hydrogen from the action of the carbon upon the melt. The free energy in the gas battery when the caustic soda is fused without water agrees well with the quantity known for a long time to be developed by the decomposition of water when the caustic soda which is fused contains moisture.

Niagara.—Mr. Orrin E. Dunlap writes from Niagara Falls:—"An announcement of considerable importance, as concerning the future application of a portion of the power to be developed on the Canadian side at Niagara is to the effect that the Ontario Power Co. has entered into a definite contract with the Niagara, Lockport and Ontario Power Co., whereby the former is to deliver to the latter 30,000 E.H.P. by July 1st, 1905, and an additional 30,000 H.P. by January 1st, 1907, making 60,000 H.P. in all. The contract is made for a period extending to April 1st, 1950, but may be renewed 60 years longer, or until 2010. Under the agreement, this power is to be delivered by the Ontario Power Co. at the boundary line in the vicinity of the whirlpool, where the Niagara gorge is narrow, and at which point a transmission line is likely to be erected. The indications are that the Niagara, Lockport and Ontario Power Co., will build a transformer station at or near the whirlpool, and, under the agreement, it is to build a transmission line extending as far east as Rochester by July 1st, 1905. The performance of this contract is guaranteed by the forfeiture of a specific sum as liquidated damages in case of non-performance. It is intimated that this contract is made with the Ontario Power Co. by the Lockport Co. for the reason that it would require a long time to develop power in the vicinity of Lockport, and thus indications are that the long-reported prospective development at or near Lockport is very remote, for this contract is for 50 years, with privilege of renewal for 60 years more. The Ontario Power Co. is erecting a power station at the water's edge in the gorge on the Canadian side of the river, and has already installed its first steel flume, which has a diameter of 18 ft. The company's plan is to place three of these flumes, each of which is intended to supply water enough for developing 60,000 H.P."

Thermo-electric Properties of Certain Alloys.—At a recent meeting of the Russian Physico-Chemical Society, a paper was read by N. N. Turin, describing the results of his experiments upon the thermo-electric behaviour of tin-lead, tin-bismuth, lead-bismuth, and a few copper-zinc alloys. They were examined in contact with copper at the temperature of boiling water, and at that of melting ice. It was found that the potential of the tin-lead alloys was constant, and independent of their composition; but that of the bismuth-tin, bismuth-lead, and copper-zinc alloys varied both in magnitude and sign according to their composition. The maximum potentials were met with in alloys corresponding almost exactly with the formulæ $SnBi_5$ and Bi_2Pb. The lead-bismuth and copper-zinc alloys exhibited certain ranges of composition within which the E.M.F.'s were constant; in the former case this occurred with alloys containing 65 per cent. or more of lead, and in the latter with alloys containing between 10 and 25 per cent. of zinc. The copper-zinc alloys showed at least two maxima and two minima. On keeping, the alloys of bismuth with tin and lead exhibited alterations in constitution or condition which caused decreases in their potentials. The experiments are being continued.

Caustic Baryta and Acetylene-Lampblack.—According to H. Becker, a curious process which yields acetylene-black as a by-product in the manufacture of caustic baryta (or barium hydroxide, rather) is in operation at Foligno, in Italy. The residues obtained when crude sugar is purified by the baryta process, *i.e.*, by treatment with barium hydroxide and then with carbonic acid, consist of moist barium carbonate. This is mixed with the necessary proportion of carbon, and fed into an electric furnace, where it is converted into barium carbide. The carbon monoxide evolved is burnt, and the heat generated is employed to dry the raw materials before they reach the hearth of the furnace. The carbide produced is immediately decomposed with water so as to obtain barium hydroxide, and the acetylene liberated is decomposed into carbon ("acetylene-black," the already tried pigment) by some undescribed patent method.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the power station or the commercial side of the profession and industry also electric tramway and railway officials, to keep readers of the Electrical Review *posted as to their movements.*

Central Station Engineers.—The Sunderland Corporation electric lighting staff held their fifth annual dinner on December 7th. About 100 sat down, under the presidency of Mr. J. F. C. Snell, the borough electrical and tramways engineer. The toast, "The Mayor and Corporation of Sunderland," was moved by Mr. C. Donkin, and responded to by the Mayor, who observed that he and other users were looking forward to the time when there would be a reduction in the price of current. After the toast "Our guests" had been responded to, Councillor Summerbell proposed "The Electricity Department," and expressed the hope

that the cost of power to the Tramways Committee would soon be reduced by the Electricity Committee. Alderman Bruce, chairman of the Electricity Committee, responded, and congratulated Mr. Snell upon the efficiency of his staff and department. The units in 1904 were 3,500,000, but they estimated that, for the current year, they would be 4,650,000. The ratepayers of Sunderland, as ratepayers, had not contributed a single penny towards the cost of the undertaking. The expenses had been earned by the undertaking itself. At the end of the present year they expected to add £9,000 to the sinking fund. They had been asked to reduce the price, and he hoped that, when the accounts were made up for the present year, they would be able to indicate a reduction in the price. At present they had six shipyards and engineering shops receiving power from them, and they expected to add to these the yards of Messrs. Short Bros. and Sir James Laing & Sons. Councillor Dixon proposed the health of the chairman, which was enthusiastically honoured, and Mr. Snell, after responding, presented a silver-mounted stick to the secretary of the dinner (Mr. J. Hoey).

Mr. A. J. Beckett, formerly assistant electrical engineer at York, has been appointed electrical engineer at Bridlington at a salary of £220 a year, rising to £250. An assistant is to be appointed at a salary of £100.

The Hanley T.C. has appointed Mr. P. J. G. Swinney, of Burton-on-Trent, as junior assistant at the electricity works at a salary of £100.

The St. Annes U.D.C. has increased the salary of the electrical engineer, Mr. J. H. Clothier, by £25 a year, with a further increase of £30 next April.

The first annual dinner of the Glasgow Corporation electricity department was held on Wednesday, 7th inst., in the Grosvenor Restaurant. Lord Provost Sir J. Ure Primrose, Bart., presided over a company which numbered 220. Mr. W. C. Martin, in proposing the toast of "The Electricity Department," said that in 1893, when the committee's first balance-sheet was issued, the number of consumers was 108. Ten years later it was 7,013. Last year it was 9,324. The capital expenditure in 1893 was £97,000, and 10 years later it had reached £1,000,000.

Mr. J. E. Teasdel, deputy electrical engineer at Cardiff Municipal Electricity Works, was, on December 8th, presented by the electric light and tramway employés with a gold watch and chain, a case of cutlery, and a cigar case on his departure to take up the position of chief engineer and manager of the electric light and tramways system at Pontypridd.

From the 147 applicants for the post of electrical engineer to Leigh Corporation, the Electricity Committee selected the following short list:—W. Ainscough, Leeds; H. C. Caldwell, Altrincham; D. A. Hamilton, Lancaster; B. S. Hornby, Bolton; and A. T. Smith, of Bury.

The Kirkcaldy T.C. on Monday agreed to increase the salary of the electrical engineer, Mr O. F. Francis, from £250 to £300 per annum, and that he be allowed to take articled pupils and retain the premiums.

Mr. Chick, of Horsham Electricity Works, has been appointed senior shift engineer at the Acton U.D.C. electricity works.

Mr. John Henry Fooks Bale, resident electrical engineer, Mersey Railway, for the British Westinghouse Co. since 1902, was, on Wednesday, appointed electrical engineer to Battersea Borough Council at a commencing salary of £400 a year. There were 108 candidates.

Mr. F. J. Arthur, of Surbiton Electricity Works, has been appointed engineer-in-charge at the Leatherhead and District Electricity Co.'s new sub-station.

Tramway Officials.—Mr. W. F. Endean, inspector of the Devonport and District Tramways, has been appointed manager of the B.E.T. Co.'s system at Middleton.

General.—A new Chair of Electrical Engineering has been established in the University of Birmingham as a supplement to the Lectureship in the same subject so admirably held by Dr. D. K. Morris. The first occupant of the Chair will by Mr. Gisbert Kapp, now lecturer at Charlottenburg. He is not expected, however, to return to this country until the autumn of next year, and his appointment will not take effect until October, 1905. Meanwhile, and subsequently, Dr. Morris and his staff will continue their work as before. The new and large buildings for the Department will be ready by that time. Prof. Burstall will continue to occupy his Chair, the title of which will be changed to "Mechanical Engineering," and he will have control over a great engineering block and the power station. It is not improbable that a special Chair of Civil Engineering in the narrower sense will be established. It is certain that a competent assistant will have to be elected to assist Prof. Kapp in the drawing office for dynamo and central station design.

Mr. Taylor, of Folkestone, has been appointed general clerk to the Acton U.D.C. electricity department.

Lord Rayleigh delivered a lecture at the Academy of Sciences, Stockholm, on 13th inst., on the "Density of Gases."

The Nobel Prize for "Physics" which has been awarded to Lord Rayleigh, and that for "Chemistry" which has been conferred upon Sir William Ramsay, were presented at Stockholm in the presence of King Oscar on December 10th, and a banquet at the Grand Hotel followed. It is stated that Lord Rayleigh proposes to present to the Cambridge University the value of his prize.

Mr. John Young, formerly manager of the Glasgow Corporation tramways, and now general manager of the London Underground Electric Railways, was welcomed to London on Tuesday night by some 300 or 400 fellow Scots at a smoking concert at the Great Eastern Hotel.

Obituary.—Mr. Wm. Ashmore, head of the firm of Messrs. Ashmore, Benson, Pease & Co., Ltd., electrical engineers, of Stockton-on-Tees, died on December 8th, at the age of 78 years. He established the firm 40 years ago.

NEW COMPANIES REGISTERED.

Mors, Ltd. (82,811). — This company was registered on December 8th, with a capital of £15,000 in £1 shares, to acquire English patents relating to motor cars of the Société Anonyme d'Electricité et d'Automobiles Mors, or others, to manufacture and sell in the United Kingdom and British colonies and dependencies, motor boats and accessories in accordance with such patents, to deal in motor cars and accessories made by the Compagnie Française des Voitures Electromobiles, and to carry on the business of garage proprietors, motor car and vehicle manufacturers, agents and merchants, electrical and general engineers, &c. The first subscribers (each with one share) are:—S. L. Lazarus, 3, Drapers' Gardens, E.C., stockbroker; N. Drummond, 4, Down Street, Piccadilly, W., stockbroker; L. Carle, 34, Newman Street, W., engineer; P. Lazarus, 3, Drapers' Gardens, E.C., stockbroker; D. Singer, 25, Old Broad Street, E.C., stockbroker; A. S. Parsons, 25, Old Broad Street, E.C., stockbroker; and M. A. Spielmann, 38, Gloucester Square, W., stockbroker. No initial public issue. The first directors are S. L. Lazarus (chairman), L. Carle (managing director), D. Singer, G. de Wilde, L. Haarbleicher, F. Kerr, L. Auscher, M. Drummond and C. Banbury: qualification, £100; remuneration, £350 per annum and 5 per cent. of the profits after 5 per cent. dividend has been paid; divisible. Registered office, 55-59, Shaftesbury Avenue, W.C.

Aberavon District Tramways Syndicate, Ltd. (82,801).—This company was registered on December 8th, with a capital of £2,000 in £1 shares, to apply for a provisional order or Act of Parliament authorising the construction of an electrically equipped tramway in the parishes of Aberavon and Margam, Glam., and elsewhere, to construct or acquire any tramways, sidings, buildings, plant, and equipment, and to maintain, develop and work the same. The first subscribers are:—J. Moxon, Arlington Chambers, Newport, solicitor, 100 shares; J. M. Smith, 48, High Street, Aberavon, merchant, 100 shares; E. M. Linton, Westgate Chambers, Newport, surveyor, 100 shares; H. D. W. Lewis, Prudential Buildings, Cardiff, engineer, 100 shares; E. L. Hill, Royal Chambers, Queen Street, Cardiff, engineer, 100 shares; J. A. Jones, Heathmont, Aberavon, M.D., 100 shares; and H. J. Barclay, Arlington Chambers, Newport, Mon., 1 share. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first. Registered office, Arlington Chambers, 4-5, Commercial Street, Newport, Mon.

Marlborough Electric Supply Co., Ltd. (82,810).—This company was registered on December 8th, with a capital of £1,000 in £1 shares, to carry on the business of suppliers of electric light and power, electric engineers, electricians, contractors, tramway and railway proprietors, &c., and to enter into an agreement with the Bristol Trust, Ltd., whereby the said trust undertakes in consideration of £250 to pay the costs of formation and registration and certain preliminary expenses. The first subscribers (each with one share) are:—S. Williams, 38, Parliament Street, S.W., solicitor; E. Watts, All Saint's House, Bristol, solicitor; J. P. Muse, 28, Exeter Road, Bristol, clerk; W. E. Laurence, 38, Parliament Street, S.W., clerk; W. C. Penn, 25, Victoria Street, S.W., civil engineer; W. T. Pressland, Broad Sanctuary Chambers, Westminster, electric engineer; T. Hucklebridge, 7, Grange Road, Gunnersbury, W., surveyor. No initial public issue. The subscribers are to appoint the first directors. Qualification, 50 shares.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Edison and Swan United Electric Light Co., Ltd. (18,984).—This company's annual return was filed on November 7th, when 99,261 "A," 17,139 £5 "B," and 23,564 £2 10s. "B" had been taken up out of a nominal capital of £941,090 in 150,000 "A" shares of £5 each, 26,436 "B" shares of £5 each, and 23,564 "B" shares of £2 10s. each; 10s. per share has been called up on 89,261 "A," and £44,630 10s. has been paid; £3 per share is considered as paid on 10,000, and £2 10s. per share on 89,261 "A" shares, and all the "B" shares are issued as fully paid—making a total of £397,757 10s. considered as paid. Mortgages and charges: £443,023. (The capital was originally £1,000,000 in £5 shares, but was reduced to present amount by cancelling £2 10s. per share on 23,564 "B" shares in August, 1904.)

Mills, English & Co., Ltd., electrical and mechanical engineers, Swansea and Llanelly (82,558).—£8,000 first mortgage debentures, dated November 23rd, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holders: Metropolitan Bank (of England and Wales), Ltd., 60, Gracechurch Street, E.C. £4,500 second mortgage "B" debentures, created and dated November 23rd, 1904, charged on same property, as first debentures, and subject thereto, have also been registered. No trustees.

Milford-on-Sea Electric Supply Co., Ltd. (77,043).—Issue, on November 12th, of £850 debentures, part of series created September 3rd, 1904, to secure £2,000, charged on the company's whole property, present and future. No trustees. No previous issue of same series.

Perth Electric Tramways, Ltd. (55,935).—Issue, on November 24th, of £500 debentures, part of series created December 22nd, 1903, to secure £50,000, charged on the benefit of certain agreements, deposit, provisional order and Acts of Parliament, tramways, tramway undertaking, plant and machinery, &c., in Perth, Western Australia. Trustees: Lord Arthur Butler, 7, Portman Square, W.; and J. S. Austen, 68, Dashwood House, E.C. Previously issued of same series: £35,500.

United Electric Light and Power Supply Co., Ltd. (72,024). Issue, on November 22nd, of £450 first mortgage debentures, part of series created March 17th, 1903, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital, and its buildings, machinery, and other property at Guimarães, Portugal. No trustees. Previously issued of same series: £2,375.

Jackson Bros. & Lord, Ltd., electrical and mechanical engineers, Salford (78,741).—A debenture for £100, dated December 2nd, 1904, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder: R. B. Batty, 33, Princess Street, Manchester.

Hartlepool Electric Tramways Co., Ltd. (49,734).—Particulars of a series of debentures created by resolution of November 30th, 1904, securing an amount equal to half the issued share capital, have been filed pursuant to Sec. 14 (4) of the Companies' Act, 1900. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees. (Note.—The whole of the nominal capital of £100,000 has been issued and £95,000 has been called up.)

Industrial Storage Battery Syndicate, Ltd. (76,944).—Issue, on November 14th, of a debenture for £1,000, part of series created September 6th, 1904, to secure £3,000, charged on the company's undertaking and property, present and future, including uncalled capital, subject to prior charge for £3,000. No trustees. No previous issue of same series.

Mather & Platt, Ltd. (60,387).—This company's annual return was filed on November 1st, when 40,000 preference and 40,000 ordinary shares had been taken up out of a nominal capital of £1,000,000 in 50,000 preference and 50,000 ordinary shares of £10 each. £10 per share has been called up on 29,200 preference and 2,500 ordinary shares, resulting in the receipt of £317,000. £483,000 is considered as paid on 10,800 preference and 87,500 ordinary. Mortgages and charges: Nil.

Chloride Electrical Storage Co., Ltd. (35,889).—This company's annual return, made up to August 31st, 1904, has been filed. 62,000 preference and 33,250 ordinary shares have been taken up out of a nominal capital of £135,250 in 62,000 preference, 33,250 ordinary, and 40,000 undenoted shares of £1 each. £1 per share has been called up on 48,750 preference and 16,250 ordinary shares, resulting in the receipt of £65,000. £20,250 is considered as paid on 13,250 preference and 17,000 ordinary. Mortgages and charges: £20,000.

Chiswick Electricity Supply Corporation, Ltd. (38,854).—Issue, on November 16th, of £500 debentures, part of series created November 2nd, 1900, and covered by deed of March 8th, 1901, to secure £50,000, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: W. B. Esson. No trustees. Previously issued of same series: £33,000.

Chamberlains, Ltd., gas and electric specialists, London (81,744).—Issue, on October 26th, of £60 debentures, part of series created same date to secure £300, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees.

Cassel Self-regulating Water-wheels, Ltd. (70,326).—A memorandum of satisfaction in full of debentures dated August 31st, 1904, securing £500, has been filed.

Muirhead & Co., Ltd., electrical engineers, Elmer's End (82,270).—Issue, on November 16th, of £16,000 debentures, part of series created same date to secure £20,000. Property charged: The company's undertaking and property, present and future, including uncalled capital. Holders: A. Muirhead, D.Sc., F.R.S., The Lodge, Shortlands, Kent; and F. L. Muirhead, M.A., LL.B., Downe Lodge, Downe. No trustees.

ELECTRICITY SUPPLY ACCOUNTS.

Cardiff Municipal Electricity Supply.

The annual report on this undertaking for the last year's working, issued by Mr. Arthur Ellis, the borough electrical engineer and manager, makes good reading. Electricity supply work in the Cardiff area is evidently making rapid progress, as to which the figures given below speak for themselves. The most important features are the public lighting (for which a moderate figure is charged) and the power supply. The latter, indeed, promises to acquire an additional 300 B.H.P. of motor connections in the near future, and it is contemplated to put down three-phase plant specially to deal with it at an early date.

The works costs are a steadily improving feature, as might be anticipated, with a load factor approaching 16 per cent. It is to be noted that the total working costs (£17,838) include a sum of £6,225 for energy supplied by the Corporation Tramways Department from Roath power station, as against some £1,655 paid in the same way in the previous year. During the past five years the output returns of the undertaking are as follows:—

Year.	Units sold.	Increase on previous year.	Number of 8-C.P. lamps connected.	Load factor.
1900	571,300	26 per cent.	17,247	11·79
1901	688,549	31 „	37,542	10·78
1902	1,005,763	46 „	51,852	12·07
1903	1,492,470	48 „	83,902	12·42
1904	2,385,472	59 „	109,570	15·81

The rates for supply are:—For private lighting on the maximum demand system, 7d. and 2d. per unit, or a flat rate of 4½d.; for power, 4d. and 1d., maximum demand; public arc lamps, £14 per annum.

General Statement.

For year ending March 31st—	1904.	1903.
Total capital expended	£183,767	£157,167
Number of units sold—		
Private consumers	1,720,713	1,267,798
Public lighting	647,918	213,809
By contract	16,841	10,863
Total number of units sold ...	2,385,472	1,492,470
Equivalent No. of 8-C.P. lamps	109,570	83,902
Number of public lamps	419 arc	224 arc
	100 inc.	98 inc.
H.P. of motors connected	582	411
Maximum load	1,713	1,372
Revenue account—		
Gross revenue	£29,368	£21,157
„ expenditure	£17,838	£11,271
„ profit	£11,530	£9,886
Average price obtained per unit—		
Private supply	3·4d.	3·5d.
Public lighting	1·9d.	2·4d.

Revenue Account for Year ending March 31st, 1904.

Gross revenue	£29,368 = 2·96d. per unit
Works and distribution costs (including public lighting)	£14,892 = 1·50d. „
Total working costs	£17,838 = 1·79d. „

Profit Statement, 1904.

Interest on loans, &c.	£5,791
Sinking fund	3,360
Balance on year's working	2,379
Gross profit	£11,530

The year's working resulted in a gross profit of £11,530, from which, after meeting financial and sundry charges, a balance remains of £2,379.

Blackpool Municipal Electricity Supply.

We give herewith the tabulated returns of the Blackpool undertaking for the year ending March 31st last. It will be seen that the total output shows an increase on the previous year, but that for public lighting less energy has been consumed, despite a considerably increased number of lamps being in use. The revenue was well maintained, and after meeting working, financial and sundry charges, a balance of £1,887 remained. The figures show a remarkable resemblance in many respects to those given above for Cardiff.

The charges for energy are:—Private lighting, 7d. and 2d. per unit, maximum demand; churches, 5d.; power and heat, 2½d. per unit. Traction, 2d. per unit up to 250,000 units, and 1½d. after. Public lighting, 3½d. per unit. Mr. Chas. Furness is the borough electrical and tramways engineer.

General Statement.

For year ending March 31st—	1904.	1903.
Total capital expended	£183,518	£177,765
Number of units sold—		
Private lighting	1,052,440	965,290
Public lighting...	231,296	266,376
Traction	1,102,078	937,796
Total number of units sold ...	2,385,814	2,169,463
Equivalent No. of 8-C.P. lamps connected	113,635	106,052
Number of public lamps	263 arc	263 arc
	463 inc.	290 inc.
Maximum load in KW.	1,776	1,730
Revenue account—		
Gross revenue	£31,652	£29,461
„ expenditure	£17,830	£16,862
„ profit	£13,822	£12,599
Average price obtained per unit—		
Private lighting	4·02d.	4·14d.
Public lighting	5·62d.	5·04d.
Traction	1·83d.	1·82d.

Revenue Account for Year ending March 31st, 1904.

Gross revenue	£31,652 = 3·18d. per unit.
Works and distribution costs (including public lighting)	£15,207 = 1·53d. „
Total working costs	£17,830 = 1·79d. „

Profit Statement, 1904.

Interest and sinking fund...	£11,468
Sundry capital repayments	467
Balance on year's working transferred to rates...	1,887
Gross profit	£13,822

CITY NOTES.

Isle of Thanet Electric Tramways and Lighting Co.

Lord Arthur Butler presided on Wednesday at Winchester House, E.C., over the meeting of this company, and in moving the adoption of the report, he referred first to the loan secured upon deposit of debenture stock £49,000, which showed an increase of £9,000. This money had been expended upon various capital items, but principally upon the extension of the electric light installation. The directors, owing to the unsatisfactory condition of the money market, had been unable to place debenture stock at a satisfactory price, and were therefore obliged to increase the loan by an additional £9,000 during the year, thinking it more prudent to wait for an improvement in the times before issuing more debentures. The balance of revenue brought forward from last year was £5,048, out of which had been deducted £473 for unascertained law costs in respect of compensation claims, and the directors had also written off this year £533 for improvement of cars. After deducting the amount of £2,454 transferred to appropriation account, the balance carried forward would be £1,559. The net balance on the revenue account was £13,493, against £12,304, showing an improvement of £1,189. The assets had increased in some instances, owing to the provision of additional machinery for lighting purposes, also additional cables, meters, &c., required to install the electric light in an increased number of private houses, shops, &c., particularly in Margate and neighbourhood. The £1,800 balance of account for

adjustment and improvement of cars, shown in the balance-sheet, would be written off in six annual instalments. This was the amount expended on reconstruction of bogie cars, owing to the objections raised by the Board of Trade to the double-truck cars. The directors regretted that they were unsuccessful in obtaining the Lighting Order for Ramsgate, which had gone to another company. The amount expended, £330 15s. 7d., would, therefore, have to be written off future revenue, unless, as was yet hoped, some arrangement might be made for the supply of current in bulk by the Thanet Co. With regard to the revenue account, the receipts during the past year from traffic had increased by £1,540, due largely to the improved weather they had experienced during the summer season, but a strict inspection of the traffic statements showed that although they carried during the year a largely increased number of passengers (4,673,611 as against 4,406,821, an increase of 226,790), a very considerable number of these were short-distance passengers, bringing them to the conclusion that their undertaking had suffered in the same manner as many other tramway companies from a depressed state of business generally, and a lesser spending power on the part of the public, who, although they took their annual seaside holiday, had to reduce their expenditure. The total miles run during the year was 857,881, against 808,914 last year; and the passengers carried were 4,673,611, against 4,406,821; the average number of cars running daily was 28, against 27; but in January only 15 were running, whereas in August 52 were running. The lighting business of the company had grown from £904 in 1903, to £2,291 in 1904, being an increase of £1,387, and though the progress might not be so fast in the present year, there was a steady increase in the demand for electric lighting in private houses, particularly in Margate, and as the directors had lately sanctioned a lower rate for current, it was hoped that the consumption of current for lighting purposes would be largely increased, with advantage to the company in the way of additional revenue. The item "carriage of parcels" also showed a slight increase over the receipts of last year. Turning to the expenses side of the account, the heading of "General expenses, traffic and general wages" showed an increase of a little over £200 over last year. This was accounted for by the larger number of cars run during the year, 10,379 against 9,874, an increase of 505 cars in the year, with an increased mileage of 48,967 miles. Compared with last year the item for accident insurance, £1,131, was a very heavy one, but an unavoidable one. The company, owing to the rather serious accidents in 1901 and 1902 had had to face either the payment of a larger premium for the insurance against third-party risks, or go through the year uninsured. In the result an insurance was effected at a cost of £1,400, and the item of £1,131 was the proportion of such insurance chargeable to revenue in the past year. Rents, rates and taxes were also an increased charge this year, owing to circumstances beyond the control of the directors, but the company were paying an additional £100 per annum this year, being the rental charged by the South-Eastern Railway Co. for running powers into their premises at the Town Station, Ramsgate. Under the heading "Power Station," coal at £5,215 14s. 6d. showed an increase of £600 over last year, which was accounted for by the increased consumption of current for lighting purposes, and also by the large number of cars run during the year. Under the heading of "Maintenance," rolling-stock showed a decrease of £970 this year, the reconstruction of the bogie cars having enabled the company to economise in this department. Permanent way repairs, of course, showed a somewhat large increase. The wear and tear on the curves at Thanet was very heavy, but he did not think, considering the length of track which had to be maintained, that exception could be taken to this item. The same remark also applied to the charges for overhead wires. The balance of profit, £13,493 4s. 9d., had been carried to appropriation account, and with the further sum of £2,454 2s. 2d. brought into this account from the unappropriated revenue of last year, debenture interest and preference dividend for the year had been paid, absorbing £13,500, interest on loan, fees to trustees for debenture-holders, stamp on registration of debenture stock, and income-tax, amounting in all to £15,947 6s. 11d. The working expenses for the whole year worked out at a ratio of 65 per cent., which would compare well with any undertaking working under similar conditions. During the summer, when the traffic was at its best, they worked at a ratio of as low as 27 per cent., whereas, unfortunately, during the winter months the receipts hardly paid for the working expenses. He would give the working expenses of some other tramway systems, which he thought might be of interest to shareholders, although, in most instances, they could not be taken as a fair comparison, owing to the peculiar disadvantages of the winter at Thanet:—Dover Corporation, 73 per cent.; Blackpool Corporation, 62·43 per cent.; Brighton Corporation, 72·34 per cent.; Bristol Tramways, 65·09 per cent.; Chatham and District, 76·58 per cent.; Gravesend Electric Tramways, 67·69 per cent.; Morecambe Tramways, 83·38 per cent.; Poole and District, 61·56 per cent.; Southend Corporation, 87·17 per cent.

Mr. H. C. Levis seconded the motion, which, after a short discussion, was agreed to.

South Staffordshire Tramways Co.

On Wednesday an extraordinary general meeting of the above company was held at Winchester House, E.C., under the chairmanship of Mr. W. S. L. Schuster, for the purpose of passing a resolution authorising the annual meeting to be held in December instead of in March.

The Chairman formally moved the necessary resolution, which was carried.

The fourteenth annual general meeting of the company followed, and the Chairman, in moving the adoption of the report, said that he had been for 10 years chairman of the company, and the board for the last 10 years had had a very difficult task, but that would probably be the last time that he would address them. The solicitors could tell them that they had had the greatest difficulty in keeping the company above water. They had been in conflict with various bodies concerned, but at last they had come to a settlement with the lessee company, which, to his mind, would be of material benefit to the company as a whole. The offer made by the lessee company in their circular of July 1st, 1904, was accepted by proprietors holding £77,405 ordinary stock, and £58,240 preference stock, and this, of course, represented a very considerable majority. The lessee company were now the largest shareholders in the concern, and it was as much to their interests as to the interests of the shareholders to do all that was possible for the company. The lessee company's nominees were people who thoroughly understood tramway management from every point of view, for no company controlled more tramway undertakings in the United Kingdom than the British Electric Traction Co. It could, therefore, be only to the interests of the shareholders to be co-partners with that concern. They had £1,590 available for distribution, and proposed to distribute as dividend £1,583 6s. 8d., leaving £7 odd to be carried forward. This meant a dividend of 2s. 10d. for the year 1903, and a dividend of 1s. 4d. for the half-year ending June 30th, 1904. With regard to the various negotiations with the local authorities, it would be seen that the completion of the sale of that part of the company's undertaking in the borough of Wednesbury still remained in abeyance. The sale to the Handsworth Urban District Council of the lines and depôt in Handsworth was completed in March, at the price of £5,250, and negotiations were still pending with the Corporation of Dudley regarding the purchase by them of that part of the company's undertaking in that borough. All these negotiations with local authorities would be greatly helped by the lessee company holding such a large proportion of the ordinary shares. All interests would be in harmony, and it would practically be a dual control. In conclusion, the Chairman drew attention to the great work the solicitors had done in connection with the company.

Mr. Davis seconded the motion, and the report was adopted without discussion.

The retiring directors—the chairman and Mr. S. R. Blundstone—were re-elected.

Prospectus.

The prospectus of *Raworth's Traction Patents, Ltd.*, is now before the public, and the list of subscriptions for the 15,000 preferred ordinary shares of £1 each will close on or before Tuesday next, 20th inst. The nominal capital is £30,000, and the price to be paid for the patents, patterns, drawings, and uncompleted orders is £18,600, as to £15,000 in fully-paid deferred ordinary shares, and as to £3,600 in cash. The objects of the company are already known to our readers, they being the acquisition of the British patents granted to the vendor, Mr. J. S. Raworth, for the system of automatic regenerative control of electrically-propelled vehicles, and for the demi, or one-man car. The company will carry out conversions of existing cars for regenerative control by its own staff, and grant licences to the principal electrical manufacturing companies. The prospectus gives particulars of orders for equipments which have been received from various tramway authorities, also a list of patents. The directors of the company are Messrs. C. Shirreff B. Hilton, Thomas Browett, G. F. Metzger, A. K. Baylor and J. S. Raworth. The secretary is Mr. John I. Hall, 2, Queen Anne's Gate, S.W.

Power Gas Corporation.

Sir Henry Fowler presided at the meeting held at Westminster Palace Hotel, on 7th inst., and said that the progress and profits of the business had been adversely affected during the year by the depression in the general engineering trade. The most favourable time for selling gas plant was when manufacturers were either building new works or making extensions to the old ones. It was almost hopeless, except in very prosperous times, to expect manufacturers to discard their steam plant and substitute gas power, even though it were possible to demonstrate the many advantages that they would obtain by the alteration. They had secured the principal contracts which had been placed during last year for power-gas installations in this country. Beyond the all-important question of the general state of trade, there was another consideration which weighed largely in the minds of engineers when considering power-gas installations, and that was the degree of perfection now attained in the construction of gas engines of large powers. On the Continent, especially in Germany, the builders of large gas engines had been far better supported by manufacturers than in this country, and, no doubt, by reason of their wider range of experience, the Continental gas engine builders had succeeded more rapidly in producing reliable gas engines of large sizes than had been the case hitherto in this country. It was, however, satisfactory to note that some of the most important engine builders in this country had now complete arrangements for securing the advantage of the Continental experience, and were now manufacturing large gas engines of some of the best of the foreign types—for instance, the Oechelhaeuser engine, the Körting engine and the Cockerill engine. Electricity could be produced cheaper by Mond gas-driven generators than in any other way; but engineers of central electric stations in this country had not yet made up their minds as to the feasibility of running large gas engines in parallel for the production of alternating current, although many

such installations could be seen running in parallel abroad, particularly in Germany. They hoped that the North-Western Electricity and Power-Gas Co. would now soon place itself on a working basis, and proceed with the erection of its first central electric station, which was to be driven by power-gas and large gas engines, and would thereby furnish an object lesson, the importance of which to the development of their business could not be overestimated. Perhaps the most important new ground that they had broken was in the direction of electric tramway work.

The India-Rubber, Gutta-Percha and Telegraph Works Co.

The directors' report for the year ending September 30th, 1904, to be presented at the meeting of the shareholders, to be held at the offices on Tuesday, December 20th, reads as follows:—

The accounts show, after provision for doubtful debts, a net profit of £11,344. Adding £66,930 brought forward, and deducting £12'500 interim dividend paid in June, there remains a disposable balance of £65,774. The directors recommend the distribution of a dividend of 5s. per share, free of income-tax, amounting to £12,500, making, with the interim dividend paid in June, a total payment of 5 per cent. for the year, and leaving £53,274 to be carried forward. The general business of the company shows an increase when compared with last year, but, unfortunately, the sales have been made on a rapidly rising market for raw material, and the selling prices of manufactured goods have not proportionately increased. Moreover, the revenue for the year has been charged with amounts expended on the development of a new business which has not yet reached a remunerative stage. These two causes account for the serious falling off in revenue, but the directors think that the revenue for the current year will not be injuriously affected to a like extent. The *Dacia* and *Buccaneer* have been employed in cable-repairing work during the year, and these two vessels are at present under charter. The works at Silvertown and Persan have been maintained in their usual state of efficiency, and extensions continue to be made. In April last the board made an issue of £100,000 second debentures.

Lancashire Power Construction Co.

The report for the period ended September 30th last states that there remains £90,000 still to be called up on "A" shares and £116,000 of "B" to be issued. The directors anticipate that the further calls on the "A" shares will require to be made and the "B" shares to be issued (to the contractors under their respective agreements) during the next few months. Satisfactory progress has been made with the construction of the power station at Radcliffe, and the directors expect to have these works ready for supplying power early in the coming year. Negotiations are proceeding with a number of the local authorities for giving a supply in their respective districts, and an agreement has already been entered into with Swinton and Pendlebury.

W. R. Sykes Inter-Locking Signal Co.

Major-General C. S. Hutchinson presided at this company's meeting on 9th inst., and said that the directors proposed to pay the same dividend this year as was distributed last year—6 per cent.—and to carry forward the same amount within £160. The orders received during the year for the company's specialities, as well as for ordinary signalling, had increased both in number and in value, and the works were very busy. The new workshops referred to at the meeting last year had been practically completed; one of them had been, and the other shortly would be, fitted with the necessary machinery. This valuable acquisition and addition to the works had enabled the company to undertake larger contracts, combining both electrical and mechanical fittings, as well as to execute the orders more speedily. He might state that the whole cost of the additions had been paid for out of revenue—a circumstance which to some extent accounted for the fact that the directors were not able to declare a larger dividend.

Provincial Tramways Co.—The directors recommend a final dividend of 3s. each on the ordinary shares, making 6s. per share for the year ended September 30th, placing £7,000 to depreciaton, and carrying forward £3,400.

Stock Exchange Notices.—Applications have been made to the Committee to allow the following securities to be quoted in the Official List:—

Auckland Electric Tramways Co., Ltd.—Further issue of £85,100 5 per cent. first mortgage debenture stock redeemable.

Birmingham and Midland Tramways, Ltd.—£200,000 4½ per cent. debenture stock, redeemable.

The Committee has appointed a special settling day as under:—

Wednesday, December 21st.—Calcutta Electric Supply Corporation, Ltd. Further issue of 20,000 ordinary shares of £5 each, £3 paid, Nos. 60,001 to 80,000, and has ordered same to be officially quoted.

Blackpool Electric Tramways (South), Ltd.—A meeting of the debenture stockholders has been convened for December 22nd for the purpose of considering their position.

British Thomson-Houston Co.—The annual meeting was held yesterday afternoon, at 83, Cannon Street, E.C., for the adoption of the report.

Eastern Telegraph Co.—Interim dividend of 1¼ per cent. on ordinary stock for the quarter ended September 30th.

Eastern Extension Telegraph Co.—Interim dividend of 2s. 6d. per share for the quarter ended September 30th.

STOCKS AND SHARES.

Wednesday Evening.

If anything, investment business shows a tendency to improve. This, on the eve of the Christmas week, augurs hopefully for that fresh revival which the Stock Exchange declares will come after the holidays. The outsider might cynically suggest that stockbrokers always look forward to a period "after" something else, and that their anticipations seldom materialise into reality. Nevertheless, it would not be difficult to catalogue a variety of causes that ought to make for better business, and in the meanwhile the investor, as already stated, has by no means deserted the markets.

Generally so immobile, the price of India-Rubber, Gutta-Percha shares has fallen nearly £4 upon the issue of a disappointing dividend and report. Rumour was busy last week with the impression that some reduction might be looked for in the dividend, and for several days before the announcement appeared it was almost impossible to get a dealing price in the shares. But the figures were worse than had been looked for, and the price is now called 15 to 16, against the 19¼ of a week ago. Other manufacturing shares, however, are generally better. There is another rise in British Aluminium Preference, which brings the price to 7⅞, or 35s. better in 10 days. Yet the 6 per cent. "A" Preference are nominally 5s. lower at 8⅝, although actually the price has not changed. Crompton's rose ¼ to 1⅝, and the Debentures have more than recovered their relapse, being three points better at 95½. Weakness continues to characterise Westinghouse Preference shares, which are now 2⅞, the Debenture stock being 89. The company received a good advertisement at the Metropolitan Railway luncheon on Tuesday. British Thomson-Houston Debenture is 101.

Metropolitan Amalgamated Carriage shares are 1 1/16 for the Ordinary and 1 3/16 for the Preference, and may come into notice through the railway function just mentioned. The undertaking is managed from Birmingham, where the shares are well thought of. There is a 4½ per cent. Debenture stock that looks reasonably-priced at its current level of par.

Telegraph issues again exhibit a long string of improvements and the strength of the market is quite exhilarating to write about. Sound investment buying controls the movement, although, as we pointed out on a previous occasion, the market for Telegraph stocks is so narrow that comparatively small demands or offers suffice to cause sharp fluctuations in the price list. The "frenzied fury" developed of late by the American Railroad department is all to the good of the cable companies, and there has been renewed bull speculation in Anglo "A," with a resultant rise of ⅜ in the quotation. But the Ordinary stock has lost a point at 56. The Eastern group is sluggish, and shows little disposition to share in the tendency of the market, but the Trust issues are all better, Globe Ordinary securing a ⅜ advance to 10¼. The Preference rose ¼ to 14, and Submarine Cables Trust Certificates are a point up at 121½. National Telephone stocks are also good upon the advent of dividend time: the Deferred marks a rise of 3 at par, and the Preferred is ½ higher at 109. United River Plates rose another 2s. 6d., and Monte Video scored a florin advance. Chili Telephones have not altered. We regret to observe a widening of official prices in the list. Contraction is wanted much more imperatively.

Once more it is the Electricity Supply market that provides least subject for attention, by reason of its steadiness. Edmundson's Ordinary at 6¼ has hardened a fraction, and County of London fell 5s., to 9¼, while South Metropolitan lost 1/16 at 17s. 6d. middle. Metropolitans moved up ¼ to 16⅜. Otherwise there is no appreciable movement. We are glad to see that Charing Cross Preference has been sent out in the Official List at the odd-locking price of 5 9/16 to 5 13/16. There is a strong Stock Exchange prejudice against quoting what members call a "crooked price," of which these figures furnish a good illustration, but since the price gives a better idea of the actual state of the market than would be gained by calling it 5⅝ to 6, we cannot see where valid objection exists. Two or three other instances of a similar kind are noticeable this week.

Central London Ordinary has been down to 90 this week, but firmed up to 92 again, thus showing no change. Nor are any of the other purely electrical stocks altered, except Great Northern, Piccadilly, and Brompton Ordinary, which eased off to 9. Metropolitan stock remains at 98, and Districts dropped ½ to 40½. Traction descriptions call for no special comment. Calcutta Tramways are being dealt in about their middle price of 8, and there is still a dulness in London United Tramways issues. Whenever these give way, inquisitive folk drop hints about the possibility of more money being required for extension purposes.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Dec. 7th.	Closing Quotations Dec. 14th.	Business done week ended Dec. 14th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	100 —103	100 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	1 — 1⅛	1 — 1⅛	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,950 Red.	100	..	..	..	.. — ..	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	56 — 58	55 — 57	56	55½
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	102 — 104	102 — 104	103¼	102
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	11¼— 11⅝	12¼— 12⅝	12⅝	11¼
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	7 %	5⅝— 6	5⅝— 6	..	..
18,333,300$	Commercial Cable	$100	8 %	8 %	..	170 —190	170 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	92 — 95	93 — 96	95	..
16,000	Cuba Telegraph	10	4 %	6¾%	5 %	8⅞— 9⅛	8⅞— 9⅛	9⅛	8⅞
6,000	Do. 10 % Pref.	10	..	..	..	16⅞— 17⅛	16⅞— 17⅛	..	..
12,931	Direct Spanish Telegraph, Ord.	5	..	..	..	2⅞— 3⅛	3⅛— 3⅜	3⅜	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7⅞— 8	7⅞— 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	101 —103	101 —103	..	..
60,710£	Direct United States Cable	20	8½%	8½%	8 %	10⅞— 11	10⅞— 11	10⅛	10⅞
81,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	101 —103	100 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	133 —136	133 —136	136	133½
1,955,565	Do. 3½ % Pref. Stock	100	..	..	..	88 — 90	88 — 90	88⅝	88½
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —107	105 —107	105⅜	105⅛
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	13½— 13⅝	13¼— 14	13⅝	13½
320,000£	Do. 4 % Deb. Stock	Stock	..	..	..	106 —108	106 —108	107⅛	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	101 —103	101 —103	101½	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	100 —102	100 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	£3 16 7*	5½%	9⅞— 10	10⅛— 10⅜	10⅝	10⅛
180,042	Do. do. 6 % Pref.	10	..	..	..	13⅞— 14	13⅞— 14⅛	14⅛	13⅞
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	15 %	29 — 29½	29 — 29½	..	..
54,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	101 —103	101 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10%	10 %	44½ — 46½	44½ — 46½	45⅞	..
72,680	Monte Video Telephone Co., Ltd., Ord.	1	2½%	3 %	3 %	⅞— ⅞	⅞— ⅞	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	6 %	108 —109	108½ —10 4½	109	108
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	96¼— 97½	99½—100½	99	97
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	12 — 13	12 — 13	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5½— 5⅝	5½— 5⅝	5⅝	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 — 99	98½— 99½	98½	98⅛
689,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	104⅛—105½	104⅛—105½	105½	..
1,000,000	Do. do. Prov. Certs., 35 % to be paid	..	..	..	..	67⅛— 68½	67⅛— 68⅛	68⅛	67⅛
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6½%	1⅜— 1⅝	1 — 1½	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1⅛— 1¼	1⅛— 1½	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	98 —100	98 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6⅞— 7⅛	6⅞— 7⅛	7⅛	..
3,808	Submarine Cables Trust	Cert.	..	..	..	119 —122	119 —122	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	6⅛— 6⅞	6⅝— 6⅞	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	105 —107	105½—107½	106	..
15,609	West African Telegraph, Shares	10	..	2 %	4 %	7⅛— 7⅜xd	7⅛ — 7⅜	..	..
30,008	West Coast of America, 1 to 30,000 and 53,001 to 53,008	2½	..	..	..	⅛— ¼	⅛— ⅜	⅜	¼
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Brss. Sub. Tel.	100	..	..	..	98 —100	98 —100	..	..
267,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	13½— 13⅞	13½— 14	13⅞	13⅞
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	103 —105	103 —105	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	101½—103½	101½—103½	..	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜— ½	⅜— ½	..	..
34,568	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	7½— 8	7½— 8	8	7⅞
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	6⅞— 7⅛	6⅞— 7⅛	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	103½—105½	103½—105½	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

90,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	7 — 7⅛	7⅛— 8	..	..
10,000	Do. do. "A" 6 % Cum. Pref.	10	..	..	..	8½— 9⅛	8½— 9⅛	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	96 —100	96 —100	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9⅜— 10⅛	9⅜— 10⅛	9⅜	9⅜
100,000	Do. do 6 % Cum. Pref.	10	..	..	..	10⅜— 11	10⅜— 11	11	10⅛
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	117 —119	117 —119	118⅜	..
	Do. do. 4½% 2nd Deb. Stock Red.	100	..	..	..	95 — 97	95 — 97	..	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	5¼— 5⅜	5¼— 5⅜	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —105	102 —105	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	⅜— ½	⅜— ½	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	⅜— ⅝	⅝— ⅞	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	6 %	1 — 1⅛	1⅛— 1⅜	1⅜	1⅛
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	98 — 96	93 — 96	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	69 — 73	68 — 72	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	12½%	9⅛— 10	9⅛— 10	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —106	104 —106	..	..
1,960,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 93	91 — 93	92	91
494,098	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —103	101 —103	101½	..
494,993	Do. do. Def. do.	Stock	4 %	4 %	4 %	84 — 86	84 — 86	84	..
1,830,000	City and South London Railway	Stock	2 %	3½%	2¾%	46 — 47	46 — 47	47	46½
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1⅜— 1⅝	1⅝— 2	1⅞	1⅝
100,000	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	90 — 95	93 — 98	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	⅝— ⅞	⅝— ⅞	⅝	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	1 — 1⅛	1 — 1⅛	..	..
344,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	78 — 83	78 — 83	..	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	79 — 84	79 — 84	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	6 %	4 %	1⅜— 1½	1⅜— 1½	..	..
81,390	Do. do. 7 % Cum. Pref., 1 to 81,390	2	..	..	..	2¼— 2⅜	2¼— 2⅜	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	98 —100	98 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½— 10	9½— 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	91 — 96	91 — 96	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	10½— 11	10½— 11	..	..
200,000	Do. do. 4½ % Pref.	5	..	..	..	5⅜— 5⅝	5⅜— 5⅝	5⅜	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	110 —112	110 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	19 — 19½	15 — 16	15½	15⅞
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102	99 —102	..	..
87,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	3½— 3⅝	3½— 3⅝	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10½	10 — 10½	..	..
87,850	Telegraph Construction and Maintenance.	12	20 %	20 %	20 %	38 — 40	38 — 39	39	38½
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	103 —105	103 —105	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	88 — 90	88 — 90	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List

(Bank rate of discount 3 per cent. (April 21st, 1904).

SHARE LIST OF ELECTRICAL COMPANIES (continued). — ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations Dec. 7th.	Closing Quotations Dec. 14th.	Business done week ended Dec. 14th, 1904. Highest.	Lowest
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	† £5	8%	8 %	10 %	10½ — 11	10½ — 11	..	..
20,000	Do. do. 7 % Cum. Pref. ..	£5	..	..	..	10½ — 10⅞	10½ — 10⅞	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	£100	..	..	..	104 —107 xd	104 —107	..	..
50,000	Charing Cross and Strand Electricity Supply	£5	10 %	10 %	8 %	8¼ — 8⅜	8¼ — 8⅜	8⅜	..
70,000	Do. do. do. 4½% Cum. Pref. ..	£5	..	..	..	5⅛ — 5⅜	5 1/16 — 5 3/16	5 3/16	5 1/16
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	£5	..	..	..	4⅞ — 5	4⅞ — 5	4 15/16	..
40,000	Do. do. 1903	£5	..	..	..	4⅛ — 5	4⅛ — 5	4 3/16	..
250,000	Do. do. 4 % Deb. Stock Red.	£100	..	..	..	103 —105	103 —105	104	..
44,486	*Chelsea Electricity Supply, Ord.	£5	4 %	4¼%	5¼%	6⅛ — 6⅜	6⅜ — 6⅝	..	..
150,000	Do. do. % Deb. Stock Red.	Stock	..	..	..	109 —111	109 —111	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	£10	5 %	5 %	5 %	10½ — 11	10½ — 11	10⅝	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	£10	..	..	..	13⅝ — 14	13⅝ — 14	13¾	..
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	128 —127	128 —127	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	£100	..	..	..	104 —106	103 —105	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	£10	4 %	4 %	4 %	9⅛ — 9⅜	9 — 9⅛	9⅜	..
20,000	Do. do. do. 6 % Pref., 40,001—60 ..	£10	..	..	..	12 — 12⅛	12 — 12⅛	..	..
400,000	Do. do. 4½% Deb. Stock	..	..	..	..	107 —110	107 —110	109⅛	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	101 —103	101 —103	102⅛	101⅜
70,000	Edmundson's Electric Corporation, Ord. Shares	£5	7 %	7 %	7 %	6 — 6¼	6⅛ — 6⅜	6 1/16	6⅛
70,000	Do. do. 6 % Cum. Pref.	£5	..	..	..	6 — 6¼	6 — 6⅛	6 1/16	6
800,000	Do. do. 4½% 1st Mort. Deb. Stock	£100	..	..	..	106 —108	106 —108	107⅛	107½
21,000	Kensington and Knightsbridge Electric Ord.	£5	10 %	10 %	12½	12½ — 13½	12½ — 13	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	102 —104	102 —104	103½	..
110,000	London Electric Supply Corporation, Limited, Ord.	£3	..	..	..	2 — 2⅛	2 1/16 — 2 3/16	2⅛	..
49,840	Do. do. do. 6 % Pref.	£5	..	..	..	5⅜ — 5⅝	5⅜ — 5⅝	..	..
250,000	Do. do. do. 4 % 1st Mort. Deb. Stock Red ..	Stock	..	..	..	97 — 99	97 — 99	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	£10	6½%	7½%	8¾%	16½ — 16⅞	16½ — 17	16⅞	16 7/16
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	£5	..	..	..	5 7/16 — 5 5/16	5 7/16 — 5 5/16	5½	..
220,000	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	112 —117	112 —117	..	..
250,000	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 — 99	97 — 99	..	..
10,852	Notting Hill Electric Lighting	£10	6 %	6 %	6 %	14½ — 15	14½ — 15	..	..
59,000	Do. do. 4% 1st Mort. Deb.	£100	..	..	..	101 —102	101 —103	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	£5	14½%	14½%	14½%	14 — 14½	14 — 14½	14 7/16	14
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	£5	..	..	..	8½ — 9	8½ — 9	..	..
150,000	Do. do. do. 3½% Deb. Stock Red ..	£100	..	..	..	99 —101	99 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	£5	..	2½%	4 %	2⅜ — 3½	2⅜ — 3½	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	83 — 87	83 — 87	..	..
65,000	South London Electricity Supply, Ord.	£5	..	1½%	3 %	4⅛ — 4⅜	4⅛ — 4⅜	4⅜	..
100,000	South Metropolitan Electric Light and Power Co., Ord.	£1	..	..	..	⅞ — 1	⅞ — 1	..	..
50,000	(Late Blackheath and Greenwich 7 % Pref. ..	£1	..	..	..	1 1/16 — 1 1/16	1 1/16 — 1 1/16	1 1/32	1⅛
100,000	Dist. E.L.Co.) 4½% 1st Deb. Stock	£100	..	..	..	107 —110	107 —110	..	..
30,000	Urban Electric Supply, Ord.	£5	..	..	..	4 15/16 — 5 1/16	4 15/16 — 5 1/16	4 1/16	..
30,000	Do. do. 5 % Cum. Pref.	£5	..	..	..	5 — 5⅛	5 — 5⅛	5 1/16	..
200,000	Do. do. 4½% 1st Mort. Deb. Stock Red ..	£100	..	..	..	104 — 106	104 — 106	..	..
110,000	Westminster Electric Supply, Ord.	£5	10½%	12 %	13½%	12½ — 13	12½ — 13	12⅝	12⅜
28,141	Do. do. 5 % Cum. Pref.	£5	..	..	..	6⅝ — 7	6⅝ — 7	..	..

* Subject to Founders Shares. † Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS. Wednesday, December 14th.

CHEMICALS, &c.

		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.		5/-	..
a ,, Nitric .. .. per cwt.		22/-	..
a ,, Oxalic .. .. per cwt.		32/-	..
a ,, Sulphuric .. .. .. per cwt.		5/6	..
a Ammoniac, Sal .. .. .. per cwt.		42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ,, ...	per ton	£30	..
a Bleaching powder	per ton	£5 5	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£23	..
a Lead, Nitrate	per ton	£25	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£19	..
a Shellac	per cwt.	240/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£8	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.

b Aluminium Ingots, in ton lots ..	per ton	£180	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
b Babbitt's metal ingots	per ton	£48 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¼d.	..
c ,, Tube (brazed)	per lb.	9¼d.	..
c ,, ,, (solid drawn).. ..	per lb.	8¾d.	..
c ,, Wire, basis..	per lb.	7¾d.	..
c Copper Tubes (brazed)	per lb.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	10½d.	..
c Copper Bars (best selected ..	per ton	£79	£2 dec.

METALS, &c. (continued).

		Latest Price.	Week's Dec. or Inc.
g Copper Sheet	per ton	£79	£2 dec.
g ,, Rod	per ton	£79	£2 dec.
e ,, (Electrolytic) Bars ..	per ton	£70 10	..
e ,, Sheets ..	per ton	£87	..
e ,, Rod	per ton	£81	..
e ,, ,, H.C. Wire	per lb.	9¼d.	..
f Ebonite Rod	per lb.	8/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	4/10½ to 5/-	dec.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	47/6	2d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£13 2 6	dec.
g ,, ,, Sheet	per ton	£14 10	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£7 15	..
d Mica (in original cases) small ..	per lb.	6d. to 1/	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large ..	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/0¼ to 1/3	¼d. inc.
p ,, rolled bars & rods	per lb.	1/0½ to 1/3	¼d. inc.
p ,, ,, strip & sheet	per lb.	1/3	1d. inc.
o Platinum	per oz.	81/6	..
e Silicium Bronze Wire	per lb.	10d. to 11½d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£133 to £133 10	20/- to 30/- inc.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/8	¼d. dec.
p White Anti-friction Metals— "White Ant" brand ..	per ton	£48 to £65	£1 to £3 inc.
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 len. Flax	per lb.	5¾d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4 1/16d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne brd.)	per ton	£29 7 6	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co., *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Dec. 10	1,036	— 44	28	40,624	+ 5,728	10	—
Bath	,, 7	520	—	50	31,197	—	12½	—
Birmingham ..	,, 10	5,083	+160	50	268,519	+14,536	8½	—
Blackburn	,, 9	738	+ 1	36	34,879	+ 3,334	13½	—
Blackpool	,, 8	278	+ 31	36	42,697	+ 5,934	8½	—
,, —Fleetw'd	,, 10	157	— 2	23	20,763	+ 888	7½	—
,, —Lytham	,, 8	123	— 7	6	730	—	7½	+ ½
Bolton	,, 11	1,626	— 34	37	68,295	+ 488	25	—
Bournemouth ..	,, 7	762	— 8	36	40,520	—	16½	—
Bradford	,, 3	3,607	+293	33	162,147	+26,483	54	—
Brighton	,, 11	719	— 2	36	37,937	—	9	—
Bristol	,, 9	4,594	+225	—	—	—	28	—
Devonport ..	,, 2	415	— 3	48	25,517	+ 3,255	5	—
Dudley—Sto'rb'ge	,, 2	707	— 26	48	41,685	+ 1,942	18½	—
Gateshead ..	,, 2	837	+ 2	48	43,705	+ 1,358	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 2	465	+ 27	48	27,714	+ 1,398	7½	—
Oldham—Ashton	,, 2	445	— 49	48	26,306	— 1,108	5	—
Potteries	,, 2	1,629	— 19	48	82,602	+ 5,926	28½	—
South Staffs. ..	,, 2	619	—331	48	36,756	— 7,655	21½	— ½
Swansea	,, 2	444	— 38	48	26,000	+ 934	5½	—
Wolverhampton..	,, 2	321	— 6	48	18,720	— 88	10½	+8
Yorks. Wool Dist.	,, 2	463	+ 28	48	27,989	+ 8,828	6	—
Miscellaneous ..	,, 2	2,580	—	48	171,887	—	—	—
Burnley	,, 10	943	+196	—	—	—	10½	+2½
Burton-on-Trent ..	,, 4	274	+ 6	35½	12,427	—	8½	—
Cardiff	,, 3	1,816	+116	35	72,813	+ 1,653	14	—
Chatham & District	,, 8	473	— 13	49	28,578	+ 2,107	8·66	—
Cork	,, 8	431	+ 46	49	24,943	— 2,466	9·29	—
Dover	,, 10	172	— 4	49	10,611	— 284	3	—

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Dublin	Dec. 9	4,516	+182	—	117,818	— 2,473	47	—
East Ham	,, 12	583	+ 20	36	26,430	+ 1,485	6⅜	—
Glasgow	,, 10	13,419	—163	28	399,161	+20,114	72½	+ 5
Halifax (2 weeks) ..	Nov. 30	2,187	+ 29	35	53,084	+ 3,901	34½	+2½
Huddersfield ..	,, 19	1,182	+ 78	33	46,296	+ 2,986	28	—
Hull	Dec. 10	2,037	+214	36	79,605	+10,309	13	+2
Ilkeston	,, 7	93	— 17	36	5,112	+ 39	3·5	—
Ipswich	,, 10	314	+144	36	17,965	—	10½	+4
Isle of Thanet ..	,, 10	201	— 12	49	34,093	+ 1,616	10½	—
Leeds	,, 10	5,180	+141	97	215,097	+12,307	89½	+8½
Liverpool	Nov. 26	9,273	— 309	48	497,179	+13,723	108	—
London C. C. ..	,, 26	11,177	+2088	34	440,811	+94,260	47½	+7½
Manchester	Dec. 10	11,400	+663	36	444,785	+18,744	137½	+12½
Newcastle	,, 10	3,454	— 2	—	—	—	17	—
Portsmouth	,, 10	1,333	+ 46	37	73,005	+ 5,729	14½	—
Salford	,, 5	3,773	+309	35	145,909	+ 7,869	30	—
Sheffield	,, 11	4,374	+181	38	173,423	+ 8,585	34½	+1½
Southampton	,, 1	733	— 74	35	35,210	— 2,271	16½	—
Southend-on-Sea ..	,, 7	207	+ 26	36	13,761	+ 1,359	6½	—
Sunderland	,, 11	1,058	+ 70	36	46 888	+ 1,018	21	+1
Tyneside	,, 7	327	+ 73	49	19,012	+ 3,196	8·9	+·4
West Ham	,, 8	1,023	—	41	38,751	—	9·78	—
Wolverhampton ..	,, 7	694	+338	—	—	—	9·5	—
Cen. London Rly. ..	,, 10	7,099	+ 46	23	146,183	— 183	6	—
City & S. Lon. Rly.	,, 11	3,312	—146	24	62,338	— 2,306	6½	—
Dublin—Lucan Rly.	,, 9	100	+ 16	23	2,924	— 16	6½	—
G. N. and City Ry.	,, 10	1,382	+ 16	48	44,502	—	2½	—
L'pool Overh'd Rly.	,, 11	1,284	—128	24	37,670	— 2,092	8½	+4½
Mersey Railway ..	,, 10	1,555	+181	23	34,086	+ 3,022	4½	—

* Compared with the corresponding period of 1903.

THE MAGNETIC RESISTANCE OF AIR-GAPS.

The question of the fringing or spreading out of the magnetic flux at the edges of a pole-piece has always introduced a certain indefiniteness into the calculation of the ampere-turns required to pass a given flux across the gap between two pole-pieces. Dr. G. Benischke has contributed the results of some experiments carried out by him on this point to the *Electrotechnische Zeitschrift*.

The tests were made on a series of square pole-pieces, having sectional areas, s, of ·37, ·75, 1·96, 3·8 and 8·8 sq. cm. respectively, arranged as shown in fig. 1 with their faces parallel to one another, and with the exciting coils

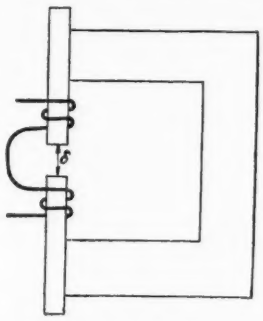


Fig. 1.

wound to within 1 cm. of the pole faces. The distance between the iron core and the inside of the surrounding coil was from 2 to 5 mm.

The poles and cores were of laminated iron (·5 mm. thick) so as to permit alternating currents to be employed, as the measurement of the total flux is simpler with these than

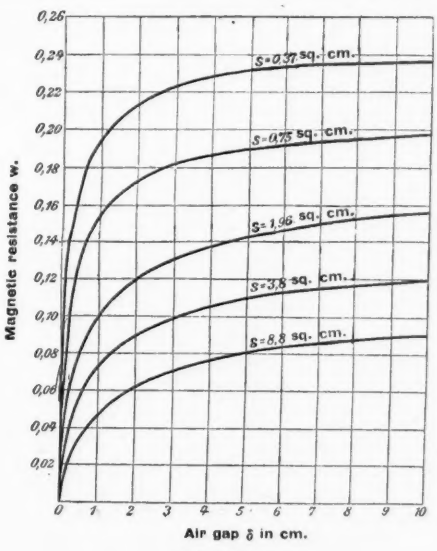


Fig. 2.

with direct currents. The value of the total magnetic resistance, w_g, is easily got at from the two expressions :—

$$Z = \frac{E \times 10^8}{4{\cdot}44 \times n \times N},$$

and

$$Z = \frac{{\cdot}4\pi \times i_m \times N}{w_g},$$

where Z = total flux ;
i_m = maximum (peak) value of the magnetising current ;
N = number of turns ;
E = the voltage ;
n = frequency.

The values of E and of the R.M.S. value of the magnetising current were obtained by means of volt, ampere and wattmeter measurements, and the value of i_m was then obtained by multiplying the R.M.S. value of the current by the ratio of its maximum to its R.M.S. value. As the iron saturation was low (B = about 5,000), and the air-gap was comparatively large, the current wave was practically of the

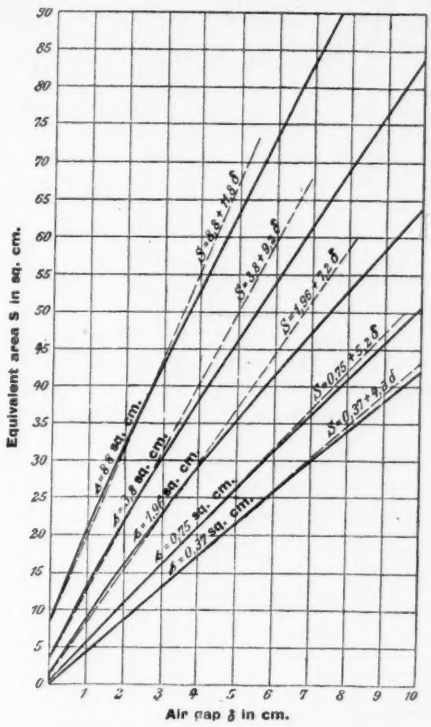


Fig. 3.

same shape as the E.M.F. wave, and as the latter was sinusoidal, the ratio of maximum current to R.M.S. current was taken as 1·4. A deduction was made from the total magnetic resistance, w_g, to allow for the resistance of the iron path, leaving w as the net magnetic resistance of the actual air-gap.

The curves connecting this resistance, w, with the length of gap δ are shown in fig. 2 for the five pole-pieces experimented on.

From these curves the equivalent cross-section, S, of the air-path, can be obtained :— $w = \frac{\delta}{S}$. Here S is the sectional area which the path would have, supposing that the flux travelled along parallel lines and at a uniform density.

The curves connecting S and δ are shown in fig. 3.

It will be seen that these curves are practically straight lines of the form—

$$S = s + k\,\delta,$$

where s is the height at which the line cuts the vertical axis (*i.e.*, the area of the path when $\delta = 0$, which is the same

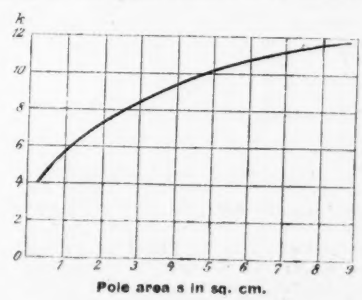


Fig. 4.

thing as the actual area of the pole face), and k is the tangent of the angle of inclination of the curve, and differs for each size of pole. Fig. 4 shows the way in which k varies with the size of pole.

By the aid of these curves it is possible to obtain the equivalent area, S, of the flux path for air-gaps up to 8 cm. long in the case of the smallest pole (·37 sq. cm.). and up to 4 cm. long in the case of the largest pole (8·8 sq. cm.) with fair accuracy. For greater air-gaps other values must be obtained for the equation from fig. 3, or the required magnetic resistance can be obtained directly from fig. 2 by interpolation or extrapolation.

The curves are directly applicable to circular pole faces, but are only approximately correct for rectangular poles in which one side is decidedly greater than the other.

The application of the above results to the calculation of the leakage in induction motors is to be discussed in a future article.

INSTITUTION OF ELECTRICAL ENGINEERS.

HYDRO-DYNAMICAL AND ELECTRO-MAGNETIC INVESTIGATIONS REGARDING THE MAGNETIC-FLUX DISTRIBUTION IN TOOTHED-CORE ARMATURES.

By Prof. H. S. Hele-Shaw, F.R.S., LL.D., Alfred Hay, D.Sc., and P. H. Powell, M.Sc., M.Eng.

(*Abstract of Paper read in London, November 24th*, 1904.)

The laws which govern the distribution of magnetic flux in space of two dimensions are identical with those which apply to the stream-line motion of a perfect incompressible fluid in two-dimensional space. If, therefore, we had such a fluid at our disposal, and, by causing it to flow between parallel bounding walls, determined the distribution of the stream-lines, this distribution would also represent that of the magnetic lines or tubes in a corresponding two-dimensional magnetic problem. This is the underlying principle of the hydro-dynamical method as applied to magnetic problems.

The stream-lines are shown by using a colourless liquid into which are injected thin colour-bands, consisting of the same liquid mixed with a suitable dye.

The liquid used by us was glycerine, and the dye for mapping out the stream-lines was a mixture of aniline dye with permanganate of potash. The colour-bands were injected through a series of very minute apertures at one end of the slide between whose parallel plate-glass walls the liquid was allowed to flow.

If the liquid is made to flow through several regions of different thickness, the ratio of the cubes of the thicknesses gives the ratio of the permeabilities in the corresponding magnetic problem.

The practical method employed by us consisted in coating one of the thick glass plates forming the slide with a thin layer of paraffin wax, and then forming a cavity or cavities of the required shape by carefully scraping away the wax over certain areas. These areas, over which the liquid layer had a greater thickness, represented the regions of high permeability. No difficulty was experienced in constructing slides in which the permeability over certain regions had as high a value as 1,000.

The stream-line diagrams which accompany the present paper are reproductions of photographs.

In the calculation of the magneto-motive-force required to produce a given magnetic flux in a dynamo having a toothed-core armature, the designer encounters two important difficulties. The first of these is the determination of the reluctance of the air-gap, including the allowance to be made for the distortion due to the armature teeth and for the fringing effect around the edges of the pole-pieces; and the second is the determination of the reluctance of the teeth themselves. It is in connection with the first problem that the hydro-dynamical method is of particular value.

Fringing Problem.—The first attempt to deal with this problem in a scientific manner is due to Messrs. C. C. Hawkins and R. Wightman, who obtained a correction for the fringing effect on the basis of certain very simple (though incorrect) assumptions regarding the form of the magnetic lines in the vicinity of the polar edges. Shortly afterwards, Mr. F. W. Carter succeeded in obtaining an exact mathematical solution of an ideal case, which, however, so closely corresponds to the actual problem, that from a practical point of view the solution may be regarded as furnishing a perfect correction.

The most convenient way of taking the fringing effect into account is to add to the length of the polar arc (in estimating the effective cross-sectional area of the gap) a term consisting of the product of the single air-gap length into a certain coefficient c, whose value depends on the ratio $r = \frac{\text{distance between pole-pieces}}{\text{length of single air-gap}}$, the "distance between the pole-pieces" being measured along the armature circumference, and hence representing the length of the interpolar arc. The following table contains the values of c corresponding to various values of r:—

r =	4	5	6	7	8	9	10	12	14	16	18
c =	1·32	1·59	1·79	1·98	2·15	2·30	2·43	2·65	2·84	3·00	3·15
r =	20	22	24	26	28	30	35	40	45	50	60
c =	3·28	3·40	3·51	3·61	3·70	3·78	3·98	4·14	4·28	4·40	4·66

By means of this table, the necessary correction in any given case may be at once applied.

Flux Distortion by Armature Teeth.—The presence of teeth in the armature core is equivalent to an increase in the gap length (or a reduction in the gap area).

Assuming that the exact effect produced by the teeth is known, a convenient method of applying the necessary correction consists in multiplying the gap length by a certain "correction coefficient," and then, using this corrected value, in proceeding with the calculation as if the armature core were smooth—*i.e.*, as if the flux distribution were uniform. The "correction coefficient" clearly represents the ratio of the maximum to the mean induction.

The value of the correction coefficient depends on the two ratios s/t and s/g, where s = width of slot, t = width of tooth (at top), and g = length of gap. Stream-line diagrams are given for various values of the two ratios s/t and s/g, and these enable us to determine the numerical values of the correction coefficient in the various cases. All that is necessary for this purpose is to determine the number of stream-lines per unit of length in the space well under cover of a tooth, and to divide this by the mean number of stream-lines per unit of length for tooth and slot. The values of the correction coefficient so obtained are given in Table I. (p. 1003).

Two well-known effects are shown very plainly by the diagrams: the *refraction* of the lines as they pass from a medium of low into one of high permeability, and the crowding of the lines along the sharp edge of the tooth.

While our experiments were in progress, a very important contribution to this subject appeared by Mr. F. W. Carter, who followed up his previous success in attacking the fringing problem by working out a solution for the air-gap flux distribution in the case of a toothed-core armature, on the assumptions of negligible pole-face curvature and infinite permeability in the teeth. According to Mr. Carter, the correction coefficient is given by

$$\frac{1+\frac{s}{t}}{1+(1-\sigma)\frac{s}{t}},$$

where $$\sigma = \frac{2}{\pi}\left\{\tan^{-1}\frac{s}{2g} - \frac{g}{s}\log\left(1+\tfrac{1}{4}\frac{s^2}{g^2}\right)\right\}.$$

Mr. Carter's solution furnishes a correction coefficient which may be regarded as quite accurate enough for all practical purposes, and a reference to Table I. shows very satisfactory agreement between the values determined by our stream-line method and those calculated by means of Mr. Carter's formula. Such divergencies as exist in

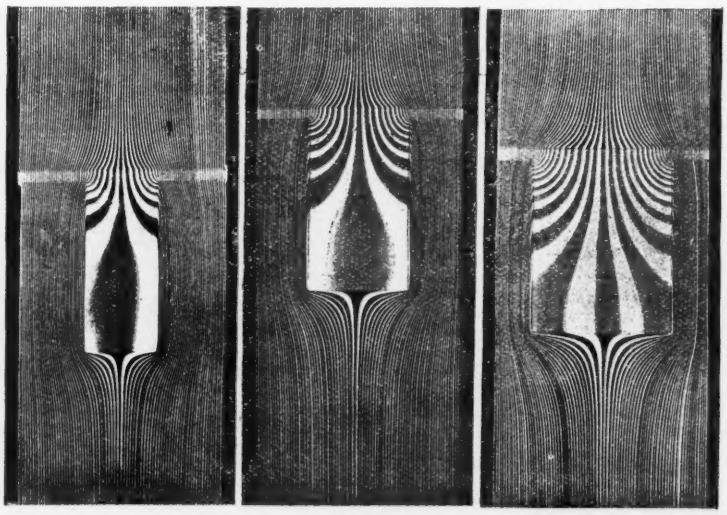


Fig. 1. Fig. 2. Fig. 3.

Examples of Stream-line Diagrams. (See Table I.)

some cases are to be attributed to want of accuracy in working out the values from the stream-line diagrams, due to their comparatively small scale.

TABLE I.—Air-gap Correction Coefficients.

Fig.	$\frac{s}{t}$	$\frac{s}{g}$	Stream-line method.	Carter's method.	Hawkins and Wightman.
—	·500	3·42	1·18	1·16	1 21
—	·510	2 80	1·13	1·14	1 19
1	·515	6·65	1·26	1·24	1·28
—	·524	2·35	1·11	1·12	1·18
—	·530	1·63	1·10	1·09	1·14
—	·670	4 57	1·21	1·24	1·30
—	·770	2·27	1·22	1·16	1 23
—	·810	4·00	1·23	1·25	1 32
2	·940	9·60	1·52	1·48	1·53
—	·945	4·30	1·31	1 30	1·38
—	1 00	4·00	1·25	1·29	1·38
—	1 00	4·40	1 37	1·32	1·40
—	1 00	4·50	1·32	1·32	1 40
—	1·02	4 45	1 35	1·32	1·41
—	1 28	3 90	1 33	1·34	1·44
3	1·88	13·2	1·98	1 95	1·95
—	1·94	3 86	1 37	1·40	1 55
—	1 98	3·34	1·39	1·36	1·51

Reluctance of Teeth in a Slotted Armature.

The object of the experiments about to be described was to investigate the exact distribution of the magnetic flux in the teeth and slots of a slotted core under varying conditions of excitation, and with varying length of gap and width of tooth.

The apparatus used was specially designed for the purpose, and was constructed in the workshops of the University of Liverpool.

The dynamo was of the single-bobbin type, with pole-pieces bored out to a diameter of 5¼ in., and into the space between them could be introduced any one out of a set of five experimental armature cores. The cores consisted of sheet-iron stampings threaded on the shaft, and maintained in position by a feather key. Fig. 4 shows the positions of the search-coils by means of which the flux was determined at the top, the middle, and the bottom of a tooth. In addition to the three coils surrounding the tooth, a fourth coil was used for the purpose of determining the total flux per tooth and slot, and the mean value of the gap induction. This coil was slung in the exact position required (the middle of the air-gap).

The reversal of flux was produced by a bodily rotation of the armature with its search-coils through 180°.

In order to arrive at a correct estimate of the net cross-section of iron in the tooth, a large number of measurements was made of the thickness of the disks forming the different cores, and the number of disks in each core was carefully counted. The exact dimensions of the various exploring coils were also determined with great care. The results of some of these measurements are given in Table II.

TABLE II.—Details of Armature Cores and Search Coils in Gap.

Diameter of core, in inches ...	5¼	5⅜	5 7/16
Number of teeth...	36	36	36
Length of single air-gap, in cm.	·340	·173	·100
Width of slot, in cm.	·5105	·528	·533
„ tooth at top, in cm. ...	·640	·671	·675
„ „ middle „ ...	·510	·528	·559
„ „ base „ ...	·430	·457	·467
„ coil in gap, in cm. ...	1·165	1·15	1·20
Length of coil in gap, in cm. ...	9·70	9·68	9·49

The magnetic flux through the top, the middle, and the bottom of the tooth was determined for five different values of the mean gap induction, ranging from about 3,000 to about 9,000 C.G.S. lines per sq. cm., for each of the five armature cores experimented upon. The results obtained are given in Table III., and a graphic example is given in fig. 5, the curves there shown having the mean gap induction for abscissæ and the magnetic fluxes through the various cross-sections of the tooth for ordinates. The full-line curve refers to the total flux through the top of the tooth, the dotted curve to the flux through the middle of the tooth, and the chain-dotted curve to the flux through the base of the tooth. The three readings marked with an asterisk in Table III. are almost certainly too low.

The ballistic measurements show clearly the steady increase in the magnetic flux as we proceed down the tooth—so long as the induction at the base of the tooth does not exceed about 20,000. Beyond this limit, another effect, not indicated by the stream-line diagrams (in which the permeability is constant), comes into play. The flux, after reaching a maximum value at a certain depth, begins to decrease, lines of induction leaving the flank of the tooth and crowding into the slot. This effect is very strongly marked for all the higher values of the gap induction, and is indicated by the crossing of the curves in fig. 5.

For the range of gap induction used, the curves connecting the total flux through the top and middle cross-sections of the tooth with the mean air-gap induction are almost straight lines through the origin. For the curves relating to the base of the tooth, the initial portion only is straight.

The experiments described in the present paper occupied the

TABLE III.

Mean gap induction.	Total magnetic flux.			Magnetic induction.		
	Top of tooth.	Middle of tooth.	Base of tooth.	Top of tooth.	Middle of tooth.	Base of tooth.
Armature 5¼ in. in diameter, 36 teeth.						
2,890	37,000	44 400	43,800*	4,790	7,040	8,570
5,010	65,800	79,100	75,900*	8,520	12,600	14 850
6,650	81,900	102,500	97,400*	10,600	16,300	19,060
7,610	98,500	118,900	111,400	12,750	18,870	21,800
8,110	103,200	125,000	112,300	13,370	19,850	21,980
Armature 5⅜ in. in diameter, 36 teeth.						
2,950	38,900	45,200	46,300	5,070	7,120	8,920
5,540	71,200	84,600	86,000	9,280	13,400	16,600
7,240	92,200	108,500	109,400	12,250	17,100	20,940
8,550	107,800	126,400	121,800	14,060	19,900	23,500
9,120	113,800	136,200	126,000	14,800	21,500	24,300
Armature 5 7/16 in. in diameter, 36 teeth.						
2,680	36 100	43 400	43,500	4,280	6,020	7,450
5,260	68,400	83,100	83,700	8,100	11 540	14,350
7,630	100,700	122,000	122,700	11,900	16,950	21,000
9,200	122,400	145 800	142,200	14,500	20,200	24,400
10,000	133,300	154 100	150,200	15,800	21,400	25,700

greater part of two years, and the expense of constructing the apparatus and photographing the stream-line slides was defrayed out of a research grant made by the Royal Society. We are

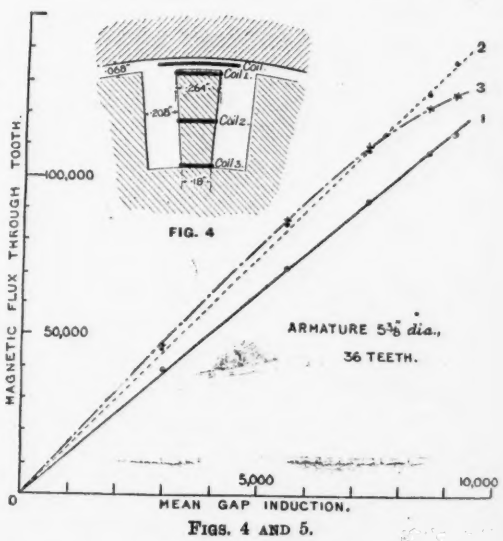


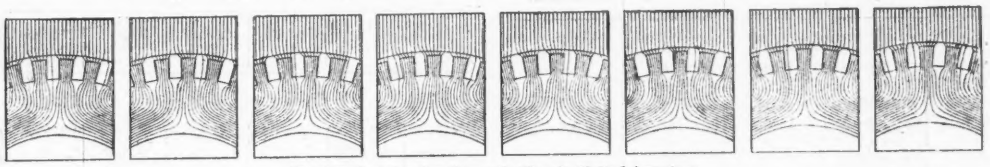
FIG. 4

FIGS. 4 AND 5.

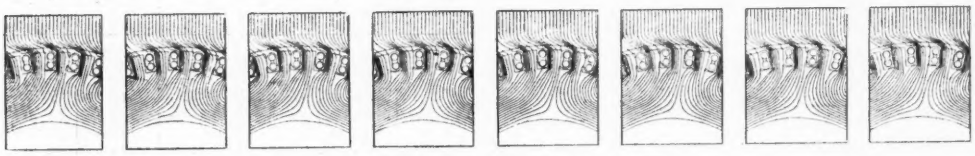
indebted to Prof. E. W. Marchant, D.Sc., and several of his students for valuable assistance in connection with the somewhat laborious experiments which form the subject of our paper.

The discussion was opened by Prof. S. P. Thompson, who referred to his earlier intimacy with Prof. Hele-Shaw, some 25 years ago. It was instructive to note the correctness with which the delineation of magnetic flux lines in metallic bodies had been arrived at by Faraday—although no proof of the correctness was possible in his day. In regard to the stream-line diagrams which had been shown, he cautioned members against taking the analogy with magnetic flux lines too far. Magnetic lines did not move, like liquid ones, nor did they poke themselves in from one end; their motion was a sidewise one, and they always formed a complete circuit. In electrical work they had to deal with either high or low permeabilities, and actually the lines of flux entered the iron at right angles, owing to its high permeability, this being somewhat different to the stream-line diagrams. It was known some years ago that the "drag" on a slotted armature came on to the teeth, and he pointed out how the magnetic flux was bunched in the teeth, and as the armature revolved, flux lines snapped across the gaps, cutting the bars. The professor then demonstrated the above points by means of the Paul animatograph. The first

illustration showed the concentric flux lines expanding and contracting round a wire when an alternating current was passing through it; the second was an ingenious illustration of the action of the flux lines when a keeper was withdrawn from and replaced on a horse-shoe magnet; the third view illustrated a slotted armature revolving in a magnetic field, showing the action of the flux lines in snapping



Third Series, showing Magnetic Flux in Slotted Armature.



Fourth Series, showing Flux Distorted by Armature Current.

FIGS. 6 AND 7.—EXAMPLES OF DIAGRAMS SHOWN BY DR. THOMPSON, WITH MR. R. W. PAUL'S ANIMATOGRAPH.

across the slots; and the fourth was of a similar kind, save that it included the distorting effect due to current passing through the armature bars. The fifth view showed the propagation of flux lines from wire placed both under and over a flat iron bar, and the final illustration was of the distribution of Hertzian waves, representing their action when starting from a dumb-bell oscillator.

Mr. ALEXANDER RUSSELL considered that the ratio r, *i.e.*,

$$\frac{\text{Distance between pole-pieces}}{\text{length of single air-gap}}$$

used in the first method of calculation of air-gap reluctance should have been taken at less than 4. He also pointed out that Carter's slots were of infinite depth, and suggested a method of plotting equi-potential lines. The stream-line method was unique, in that it showed the lines of force in metal.

The discussion was concluded on December 8th, when Dr. MARCHANT offered a few remarks in regard to the correction coefficients for fringing effects, pointing out that it was only necessary to take into account the leakage from a point opposite the corner of the pole to the point where commutation was effected. He also pointed out that it was impossible to take account of the variation of permeability by the stream-line methods. As a result of investigation into the losses in conductors on pole-tips, he had found that the induced currents therein often amounted to some 20 per cent. of those in the armature conductors.

Mr. HAWKINS referred to the value of curves of maximum and mean induction, which could be worked out from the particulars given in the paper.

Dr. HAY, in replying, remarked on the extraordinary deficiencies of text book flux diagrams. He considered the plotting of equi-potential lines as too laborious. The remarks of Dr. Marchant on armature reaction effects were important, especially in connection with alternators. Mr. Hawkins's suggestion as to curves was quite feasible, and he hoped to extend the stream-line method to the irregularly shaped teeth in induction motors, where air-gap reluctance was important.

Prof. HELE-SHAW added a few remarks in explanation of the methods described in the paper.

SOME NOTES ON HIGH-SPEED ELECTRIC RAILWAY WORK.*

By F. W. CARTER.

THE use of electricity for the propulsion of railway trains has up to the present been practically confined to local services, in which stops are frequent, and the maximum speed is not excessive. It is the object of this paper to consider what manner of problem is presented in the operation of high-speed passenger trains making few stops, and thus taking power for a great proportion of the time that they are in service.

We have to deal with heavy trains taking power almost continuously. In speed we must at least equal the performance of the modern express locomotive, which implies a maximum of approximately 75 miles per hour on level track.

One of the difficulties of this subject, especially at high speeds, is that of estimating the resistance offered to the motion of the train. At high speeds the air resistance predominates, and as this is quite independent of the weight (depending, as it does, on the external configuration of the train), it engenders a false idea to express it in pounds per ton.

Train resistance depends on the weight moved, on the type, external shape, size and number of the vehicles, on the vibration, the parallelism of axles, lubrication of journals, condition of wheels, &c., as well as on circumstances external to the train, such as quality and condition of track, amount and direction of wind, and steepness of grade.

Train resistance, in so far as it depends on the weight, is probably approximately proportional to it, and nearly independent of the velocity. Tests appear to make this portion of the resistance about 3 lbs. per ton for oil-lubricated journals; for grease lubrication the resistance may be taken as 4 lbs. per ton. The initial resistance at starting is much greater, having been found about 17 lbs. per ton in the L. & Y. Railway tests.

In so far as the train resistance depends on the configuration, size and number of the coaches, it is much more complicated than the foregoing, and varies greatly with the velocity. The resultant effect can nevertheless, from the nature of the case, be

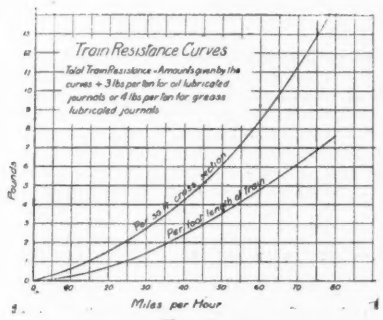

Train Resistance Curves
Total Train Resistance - Amounts given by the curves + 3 lbs per ton for oil lubricated journals or 4 lbs per ton for grease lubricated journals
Per sq ft cross section
Per foot length of train
Pounds
Miles per Hour

FIG. 1.

approximately analysed and separated into two components—one associated with the two ends of the train, and the other with the intermediate portion. As we have not tests on all types of coach, we prefer to express the former of the above components per unit length of train instead of per coach (fig. 1 lower curve), and the latter per unit area of cross-section (fig. 1 upper curve), instead of a total sum, expecting in this way to obtain an approximately correct result for types of coach not exactly similar to those which formed the subject of the tests on which the curves are based.

The total train resistance is therefore made up of a constant amount per ton, a variable amount per foot length, and a variable amount per square foot cross-section (fig. 1).

Very complete results for a particular type of English bogie stock were given in J. A. F. Aspinall's paper on "Train Resistance."* The train consisted of five L. and Y. bogie coaches and a dynamometer car, and upwards of 200 readings were taken. Unfortunately, the measurements were made behind an engine and tender, and therefore do not include the head resistance. A few readings were taken with longer trains, and from these we deduce the lower curve of fig. 1 as the amount to be charged per unit length of train.

We have no information enabling us to obtain the resistance component due to the ends of this or any similar type of train, and the upper curve in fig. 1 is taken to accord with the results of the Marienfelde Zossen tests.† It is far from satisfactory to have to

* Abstract of paper read before the Rugby Engineering Society, December 1st, 1904.

* Minutes of the *Proceedings* of the Institution of Civil Engineers, Vol. CXLVII, May, 1902.

† See "High-Speed Electric Railway Experiments on the Marienfelde—Zossen Line," by Alex. Siemens. *Journal* of the Institution of Electrical Engineers, Vol. XXXIII, May 26th, 1904.

deduce this component from so different a type of train, as one composed of a single coach, running on six-wheeled bogie trucks, weighing 83 tons, and measuring 72 ft. over buffer beams, but it is the best that we can do. As the coach is well rounded at the ends, we have taken the equivalent area as 100 sq. ft. in obtaining the curve of fig. 1 to obtain a result applicable to flat-ended English coaches.

The curves of fig. 1, being deduced from test for speeds up to 75 miles per hour, are, in the author's opinion, more reliable than anything so far published on the subject, although somewhat unsatisfactory from the meagreness of the available data. The matter is introduced here because of its great importance in connection with the subject in hand, as will be seen hereafter.

The means employed for conveying power to the train offers no features peculiar to high speed work; the train equipment alone interests us. All detailed experience on the subject is based on the continuous current series motor, and the conclusions presented in this paper are drawn from experience with this type.

required for free running, and from the horse-power we deduce the weight of the equipment, these quantities being given in fig. 4.

We see from fig. 4 that, although we are working on a conservative basis, and are allowing nothing for emergencies, such as high wind, we require upwards of 50 tons of motors in order to operate the train in question at 75 miles per hour. We could not, therefore, claim to make a very great reduction in the weight of the train by changing from steam to electricity as the motive power. The five-coach train has 20 axles; if we mounted on each axle a motor of the G.E. 66 (125-H.P.) type—such as is being used on the North-Eastern Railway about Newcastle—we should get 2,500 rated H.P. in all, or 625 H.P. for free running. We see from fig. 4 that the motors would have to be geared for a maximum speed of only 70 miles per hour, if the trains were required to run long distances with few stops, as is the case with our main line expresses.

Our conclusions as regards main line express work are these: We must design motors to suit the service, and carry them on vehicles specially constructed to suit the motors. In other words,

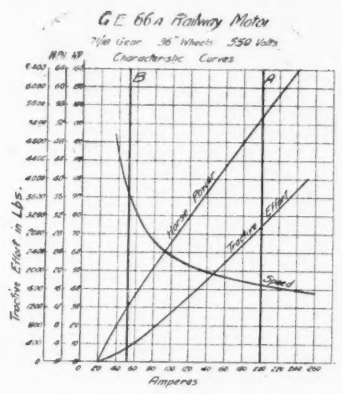


FIG. 2.

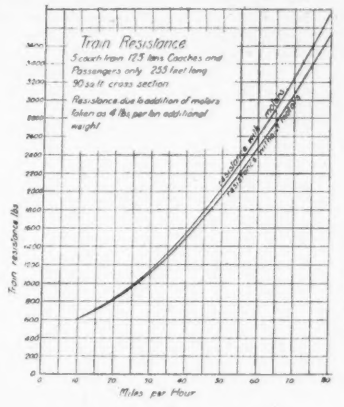


FIG. 3.

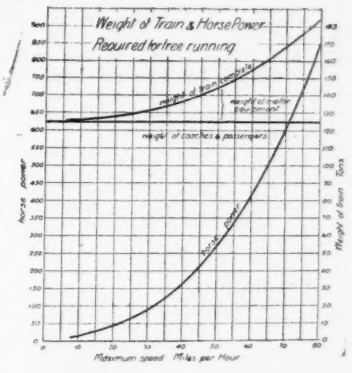


FIG. 4.

The characteristics of a typical continuous current railway motor are given in fig. 2. The line A marks the rated output, and the average accelerating current per motor is usually chosen at approximately the rated current. The rated load is that which gives a temperature rise of 75° C. as measured by thermometer placed on the hottest accessible part, after a stand test of one hour's duration with covers removed from the motor, the voltage being normal. It would not be good practice to allow the temperature to rise more than about 60° C. in normal service, otherwise exceptionally adverse conditions might lead to disaster. On surface roads it is usual to run with covers on, as it is practically impossible to let in air without letting in rain and dust.

The line B, fig. 2, shows approximately the position of free running at the maximum speed on level track, corresponding to ordinary suburban service. The continuous capacity of railway motors is of no importance in ordinary suburban work, but must be at about free running speed, where the motor is free running for the greater part of the time it is in service. It may be taken as approximately one-fourth of the commercial rating. For long-distance high-speed service, it would be quite sufficient if we could reach half the free running speed with twice the free running horse-power. However, the chief point is this, that with a given carcase we can dissipate heat at a definite rate, with a certain rise of internal temperature, quite independently of what the motor characteristics are, so that we can deduce from experience with the ordinary continuous-current railway motor, results which will apply to any motor having the same carcase.

A continuous-current equipment, such as is used on suburban railways, weighs approximately 40 lbs. per rated horse-power, including all accessories. Based on continuous rating, which we must use in comparing the ordinary type of motor with that specially suited for high-speed long-distance service, we may take the weight as 160 lbs. per horse-power. As we shall be free running for the greater portion of the time, we may take the continuous rating as the free running horse-power in accordance with the remark above. The figure of 160 lbs per horse-power is probably almost the smallest attainable with closed motors mounted on the coach trucks. We do not expect to reach nearly so high an electrical efficiency with alternating current as with continuous-current railway motors. Accordingly, for a given carcase, that is, for a given loss in the motor, the power must be less for the former than for the latter type of motor, or for a given power the carcase and the weight must be larger for alternating than for continuous-current motors.

The conclusions, therefore, that we can draw from the preceding arguments are, first, that motors for the class of service we have in view, should show less variation in horse-power with variation in speed than is usual with the present railway motors; secondly, that with motors mounted on the coach trucks, the electrical equipment will weigh at least 160 lbs. per horse-power required at free running speed.

We will now show the result of the foregoing by investigating the particular case of a five-coach train similar to that used in Aspinall's tests. The train consists of bogie coaches, and when carrying its passenger load weighs about 125 tons, exclusive of electrical equipment. The total train resistance, deduced from the curves of fig. 1, is shown in fig. 3, for the train both without and with electrical equipment. From resistance and speed we deduce the horse-power

we shall use locomotives rather than mount the motors on the train axles. The motors will be large and powerful units, probably open on the cab side to aid the dissipation of wasted energy, but closed to the weather. The usual method of rating will probably be abandoned in favour of some method more suited to the service that these motors will be called upon to perform. For main line service we should expect motors differing largely from those we are accustomed to. A considerable portion of the superstructure of the locomotive may be occupied by the motors, and in general the complete locomotive will be the designer's unit, all parts being adapted to the exigencies of the service, and of the type of machinery necessary for electrical driving.

PHYSICAL SOCIETY.

Proceedings at the meeting held on November 25th, 1904, Dr. R. T. GLAZEBROOK, F.R.S., president, in the chair.

A PAPER on "The Measurement of Small Differences of Phase" was read by Dr. W. E. SUMPNER. The author describes new voltmeter methods which may be used for this purpose, and gives the results of a number of measurements on alternating-current plant. Difficulties arising in the measurement of very small alternating-current voltages are overcome by rectifying the voltages so as to utilise sensitive direct-current instruments. The paper gives the result of some tests on two transformers of 3 KW. capacity intended to work between voltages of 100 and 1,000, and with frequencies of 100 cycles per second. One transformer was used to step up the volts from v_1 to v_2, the other to step down from v_2 to v_3. It was found that the phase-difference between v_1 and v_3 for a non-inductive load increased regularly with the current. For an inductive load there was a sharply defined minimum at low power factor. The author suggested that points on one side of the minimum corresponded to a lag, and points on the other side to a lead of the current on the voltage in the primary circuit.

Dr. A. HAY said that he had found that alternators tested with water resistances gave better results than when tested with lamps. A minimum phase-difference could be obtained by loading up the secondary of an ordinary transformer, and was due to an increase in the power factor up to a certain point and then a decrease. They were dealing with lag in both cases.

MR. A. CAMPBELL said that some years ago he published a description of the method of measuring a phase-difference, close to 180°, between two independent voltages by the first method mentioned by Dr. Sumpner, viz., by shunting the larger by a high resistance, picking off from it a part as nearly as possible equal to the other, and measuring the difference resultant. Dr. Sumpner, however, had considerably improved the method; he ensured the sufficient equality of the components by adjusting until the resultant was a minimum—a simple and beautiful device. With respect to Dr. Sumpner's method of measuring small alternating voltages by rectifying them, although it might give good results when the wave-form was known, he thought that in the very cases where such

measurements were wanted the wave-form was not known. Small difference of "power" phase may be as much due to small difference in wave-form as to small displacements of similar waves.

Mr. T. H. Blakesley said that many years ago he had made use of commutation in order to work with direct-current instruments, and found that not only the self-induction but also the capacity of the coils had to be eliminated.

Mr. W. Duddell supported Mr. Campbell in his contention that small differences of "power" phase might be due to small differences in wave-form. He had used water resistances in testing large alternators, but had never found any phase-difference between the voltage and the current.

Dr. C. V. Drysdale said he had found it advantageous to measure the sine of the phase-difference instead of the cosine. This could be accomplished by putting a condenser in series with the pressure circuit of a wattmeter so as to produce a phase displacement of nearly 90°.

Dr. W. E. Sumpner, in reply, said he had made experiments with currents of very different wave-forms, and in his opinion only about 20 per cent. of the observed results could be due to any alteration in the form of the wave. His methods were suggested as a means of getting an *approximate* value of very small phase-differences, which could not be determined in other ways.

A paper "On the Curvature-method of teaching Geometrical Optics," by Dr. C. V. Drysdale, was postponed, at the author's request, and Dr. Drysdale exhibited and described apparatus for the direct determination of the curvatures of small lenses, such as the objectives of microscopes.

Prof. S. P. Thompson then gave an "Exhibition of specimens of Crystals showing the phenomenon of Luminous Rings."

A paper "On a Rapid Method of Approximate Harmonic Analysis," by Prof. S. P. Thompson, was postponed.

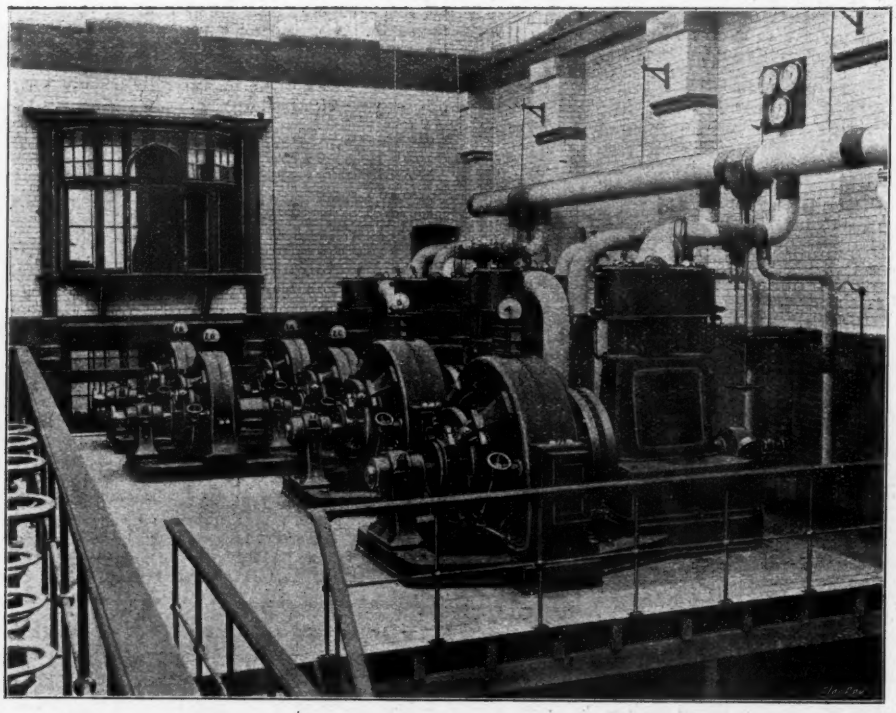
THE KILMARNOCK ELECTRICITY AND TRAMWAY SYSTEM.

The electric lighting and tramway systems for the Burgh of Kilmarnock, promoted and carried through by the Corporation, were officially inaugurated on Saturday last. The ceremony was performed by Lord Howard de Walden, Lord of the Manor, in the presence of a large company, which included Colonel Denny, M.P., of Messrs. Denny Bros., Ltd., Dumbarton; Provost Hood, ex-Bailie Wilson, convener of the Electricity and Tramways Committee; Dr. Kennedy, of Messrs. Kennedy & Jenkin, who acted as consulting engineers; Mr. Connor, of Messrs. Dick, Kerr & Co.; Mr. T. Callender, of the Callender Cable & Construction Co., Ltd.; Mr. Nelson, of Messrs. Hurst, Nelson & Co., Ltd., Motherwell; Mr. Francis, chief electrical engineer, Falkirk; and many prominent local gentlemen. The day's function passed off most successfully

The construction and management of the electric lighting and tramway systems were undertaken by the Town Council after prolonged consideration and in the face of some opposition from a section of the community. As far back as 1898 the proposal was seriously considered by the Corporation, but it was not until a year ago that it secured the sanction of Parliament to go on with the scheme.

The station and car-sheds are situated on the River Irvine at Riccarton. They occupy an extensive piece of ground, ample room being provided for future extensions. The engine room is 71 ft. 6 in. long × 37 ft. 6 in. wide, and contains four 200-H.P. Belliss & Morcom engines coupled to dynamos supplied by Messrs. Dick, Kerr & Co. At the west end of the room is situated the jet condensing plant provided by Messrs. Mirrlees, Watson and Co. On a gallery 3 ft. above the engine room floor is placed the switchboard, combined for lighting and traction, which has been built by Messrs. Cox-Walkers, of Darlington. Immediately under the gallery are the dynamo resistances, while the regulating switches are worked by means of hand wheels on the gallery. This arrangement enables them to be placed very close together, and gives the engineer in charge complete and ready control. No cable has been used in connection with the switchboard, the whole of the connections, including shunt leads, being composed of solid drawn copper rods, supported on porcelain insulators. The battery room is on the north side of the engine room, and contains 254 Tudor cells, the capacity of the battery being 360 ampere-hours. Only a very few regulating cells are supplied, the booster being kept in circuit practically all the time.

In the boiler house there are three Lancashire boilers, 28 ft. by 8 ft., constructed for a steam pressure of 160 lbs., and supplied by Messrs. Yates & Thom. The boilers are fed by means of two "Weir" direct acting pumps, which draws water either from the town mains or from the condenser discharge, and can pump either direct to boilers or through a Green's economiser composed of 192 tubes. A commodious office for the engineer-in-charge overlooks the entire engine room. The workshop in which car or machinery repairs can be dealt with, is situated to the east of the engine room, and directly in front of the car-sheds. The present accommodation is for 12 cars, but the sheds can be extended in length and width as required. The cars have been built by Messrs. Hurst, Nelson and Co., Ltd.; the wheel centres, which have steel tires shrunk on, have been supplied by Messrs. Hadfield, of Sheffield; and the motors and equipments by Messrs. Witting, Eborall & Co. The cars, which are of the ordinary double-deck description, are seated for 52 passengers. One interesting feature of the car is a movable step of a new type. Instead of folding back on itself, it is hung on levers; it can thus be swung to one side, and raised by means of a handle on the platform. When in the raised position, the step is 16½ in. above the ground, but can still be used as a step by the motorman if he requires to get off the car. The tramway route consists of ½ mile of double line, and 3¾ miles of single line. There



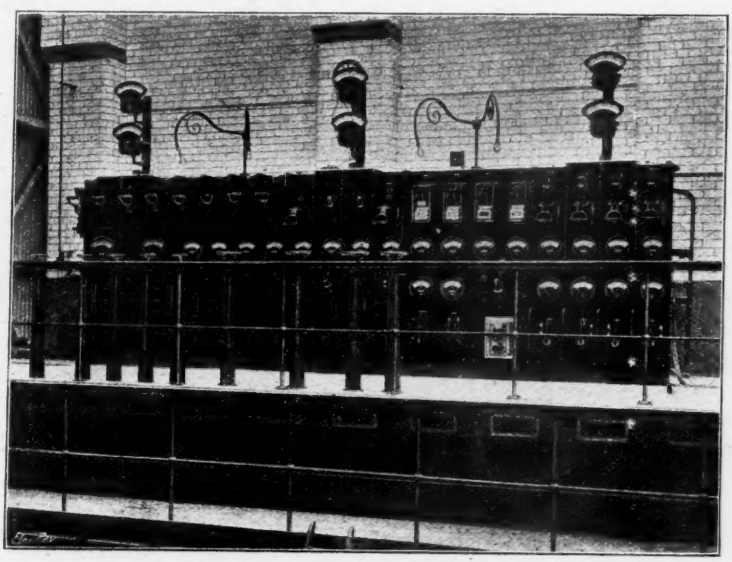
Kilmarnock: Interior of Engine Room.

are two main routes, one from Beansburn through the town to Riccarton, and the other from the railway station to Hurlford.

The track has been constructed by Messrs. Dick, Kerr & Co., under the supervision of Mr. J. E. Tarling. The rails are of the 90-lb. girder type, with a "Dicker" joint, and were rolled by the North-Eastern Steel Works, Middlesbrough. The track is "bonded" in the usual way with solid-end bonds, except at the points and crossings where drift pin-points were put in. The loop lines have been arranged about every third of a mile, and where the track is single the line has been laid to one side to permit of doubling at a future date.

The overhead equipment was erected by Messrs. R. W. Blackwell and Co. The wires are supported by bracket arms on poles in the outlying districts, and by rosettes placed on the buildings in the centre of the town. Bronze straight line hangers and pull-offs are in use throughout, the wire used being No. 00 S.W.G., the lines are divided into half-mile sections. It is proposed to run a 10-minutes' service from end to end of each route, with a five-minutes' service in the centre of the town at the busy hours of the day.

The electric light has been in use in the town since November 5th. The main thoroughfares are lit with 50 10-ampere open-



KILMARNOCK: MAIN SWITCHBOARD.

type arc lamps, constructed by Messrs. Oliver & Co, of Woolwich. Incandescent lamps are fitted on the pillars to light the streets after midnight.

The whole of the cable, both for lighting and traction, has been supplied and laid by the Callender Cable and Construction Co., Ltd. It is insulated with impregnated jute, lead-covered, and laid in troughs filled with bitumen and covered with hard brick tiles. The same firm has provided the section pillars and the signalling pillars, the latter containing telephones.

The engineering portion of the work has been in the hands of Messrs. Kennedy & Jenkin, their resident engineers being Mr. A. H. Burbridge and Mr. B. Raikes.

The total cost of the electric lighting part of the scheme is expected to reach £37,000, and the tramways £42,000, which figures are under the amounts estimated by the consulting engineer.

The price charged for the electric light is 5d. with liberal discount, 2½d. with discount for power purposes, and special terms for large consumers.

The opening ceremony took place at the power station. Mr. Nelson, of Messrs. Hurst, Nelson & Co., handed Lord Howard de Walden a souvenir motor key. His Lordship, in accepting the souvenir, said he had much pleasure in declaring the undertaking officially open. The power was thereafter applied, and the company were conveyed by six of the new cars over the routes. Lord Howard de Walden drove the first car throughout the journey.

At the conclusion of the run, the company lunched at the George Hotel, under the chairmanship of Provost Hood. Lord Howard de Walden, in proposing "Success to the electric lighting and tramways undertakings," said that he had, to a certain extent, been connected with several electrical undertakings. Kilmarnock's, however, was the largest, and so far it had proved the most successful. It had been started under the most auspicious circumstances, and he could see no reason why its prosperity should not be continuous. Ex-Bailie Wilson, in reply, said that the work had been carried out in record time; this was to a large extent due to the fact that all the men engaged on it were practically young men. Dr. Kennedy, in replying to the toast of "The Engineers and Architects," hoped that the opponents of the scheme, now that it had been carried into effect, would join with the promoters, and do everything in their power to make it a success. The actual cost of the scheme had turned out £3,200 below the estimates which he gave; that meant that the work had gone through in straightforward fashion.

Mr. A. H. Burbidge has been appointed electrical engineer and tramways manager.

The Board of Trade inspection of the car system took place on the previous day, the inspecting officers being Colonel von Donop and Mr. A. P. Trotter. Everything was found satisfactory except the open telephone wires, over the line wires. These were ordered to be insulated or run to the ground, which was done. Colonel Donop expressed satisfaction at the new movable step adopted on the cars, the invention of Messrs. Kennedy & Jenkin, and Messrs. Hurst, Nelson & Co.

VERTICAL AND HORIZONTAL TUBES IN BOILERS.

A RECENT paper by Mr. Cummins, himself an inventor of a water-tube boiler, read before the North-East Coast Institution of Engineers and Shipbuilders, is, in a way, one of the best papers that have appeared on water-tube boilers, albeit a piece of special pleading for the vertical-tube type, of which the Cummins boiler is one example.

To begin with, the author recognises the necessity of furnaces of suitable form and construction, if combustion is to be reasonably perfect with economy, and in his own boiler he has employed a brick-lined furnace as one step in the right direction, though we think his idea of a combustion chamber vertically above the grate is not calculated to secure that thorough mixture of the gases with the air which is essential.

Most of the ∧ furnace boilers with nearly vertical tubes must be culprits in the matter of black smoke, because of the passage of the hot gases between the cold tubes too directly from the furnace; but the author, who refers to the Weir boiler as one of the "vertical" tube type, neither describes it nor illustrates it. Yet, of all the vertical tube boilers, the Weir type stands *facile princeps* in its furnace form and arrangements, for it has both a furnace and a combustion chamber lined with firebrick; these are so arranged that the gases from the furnace have a chance of becoming thoroughly mixed and burned before they reach the tubes, and our own personal observation of this boiler has shown us that this end is effected. As an upholder of vertical tubes, the author is hardly impartial. He certainly describes most boilers as they usually are arranged, but he shows the Solignac boiler as though the furnace gases passed directly from the fire to the tubes, whereas in this boiler this fault is prevented by a baffle plate, and the hot gases travel to a considerable extent parallel with, and not across the water tubes, and their path to the funnel is very considerably longer than the author's illustration would seem to indicate.

We may quite agree with the author in his criticism of most of the ∧ furnace class as smoke producers, though we disagree to some extent as regards the vertical combustion chamber in its cruder forms, and do not admit the ample combustion chamber which the author considers is allowed in the furnaces of some of the well-known forms. As regards the possibility of securing good combustion chambers and proper forms of furnace, some of the horizontal tube boilers are not so deficient, after all. They can be made sound in this respect. Some of the boilers illustrated—in fact, many of them—are of American origin. The Cahall boiler is one of these, but those responsible for this boiler, which appears only fitted for land purposes, have supplied it with an external furnace—all too short, it may be, for the best results, but still a step in the right direction. Not so, however, the Climax boiler. Circular in plan, this boiler has an annular grate fired at four points, and the furnace gases rise directly amongst the water tubes. The boiler must have been designed to burn only coke, anthracite or gas. It could not, in our opinion, burn bituminous coal, nay, it would not burn some "smokeless" Welsh without a lot of smoke. Considering the relative cost of Welsh coal and more bituminous coals, it is impossible to understand how any engineer who hoped to run his plant economically could install such a boiler as this without a special external furnace. It is most difficult to get coal to such a multi-fired boiler; a boiler room full of them must surely be in a constant state of dust, dirt, and grime. The only rational plan of arranging boilers of this type is to put them in a row and give each of them a single external furnace. To pitch such boilers as this into an English boiler house without English designers having thoroughly changed the American furnace arrangements, is to neglect the laws of nature. Indeed, it is to bring a bad name upon an American product which it hardly deserves, if intended for hard coal.

On the score of circulation it may be true to a degree that the vertical tube gives a better circulation or water movement than do horizontal tubes. Yet a horizontal tube—using the words horizontal and vertical, as does the author, to describe tubes slightly inclined from the two named axes—with a restricted water inlet will give real and perfect circulation. It will not give such

circulation if its inlet is free, nor will it give it if the tube is long and manifolded like the Belleville. Indeed, this was the trouble with the Belleville, and we believe still is the trouble where hard firing is practised. But with the short single bend of the Solignac 1 in. diameter tubes, it seems impossible to overheat them. The double tubes of the Dürr, and of the Niclausse boiler, do not seem calculated to give great satisfaction.

The author favours drowned tubes. True, drowned tubes can be straight, but there can be little doubt that a tube delivering over water will give a more certain water movement than can be got with drowned tubes. An undrowned tube must be bent as a rule, though this is not a *sine qud non*. It is possible to arrange for straight tubes. We believe that a properly arranged undrowned tube will produce drier steam than will come from drowned tubes, which need greater steam space in which the water can be shed. As the author states, small tubes weigh less and have less water contents than large tubes of equal surface, so that the maximum of heating surface can be got into a given space when small tubes are employed.

Water-tube boilers require cleaning, and this is difficult to perform thoroughly. A dry steam or an air jet will serve to remove dust, but a steel brush is necessary to remove the tarry, peculiar tough substance which collects on boiler surfaces, and this brushing must be done when at work, as the deposit is then more amenable. It is difficult, in any boiler, to get a brush to the whole of the tube surface. The Cummins boiler is so arranged that every tube can be brushed on four sides, and it is thus a good boiler to clean. The author extols expanded tubes above those screwed into place, and while many boilers cannot lose a bad tube without other and, perhaps, good ones, being removed, the tubes of the Cummins boiler can all be drawn through the annular top drum, and their ends reached through suitable manholes in the lower drums.

The paper is well illustrated, and forms a useful addition to the literature of water-tube boilers from an author who has given more than the ordinary attention to the problem of combustion.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

25,801. "Improvements in reversing controllers for use in connection with electro-motors." The Electric and Ordnance Accessories Co., Ltd., R. F. Hall and J. R. Garner. November 28th.

25,811. "Improvements in means for adjusting the height of pendant electric lamps." A. C. Keeping. November 28th.

25,817. "Electrical incubator alarm." W. James. November 28th.

25,829. "An improved composite material for architectural and other analogous purposes, and for electrical insulation." S. Wohle and A. M. Hart. November 28th.

25,833. "Apparatus for regulating the voltage of alternate-current generators." M. Walker. November 28th.

25,839. "Improvements in and relating to electrolysing apparatus" E. L. Thorp. November 28th.

25,898. "Improvements in and connected with switchboards for telegraphic, telephonic and other electrical systems." B. J. B. Mills. (W. P. Hammond, United States.) November 28th. (Complete.)

25,902. "Improvements in and relating to secondary batteries." The Ekstromer Accumulator Co., Ltd, and E. L. Oppermann. November 28th.

25,903. "Improvements in apparatus for the distribution of electric current." C. W. Aktinson. November 28th.

25,905. "Improvements in and relating to electro-magnetic change speed gear for motor vehicles and boats and other purposes." P. W. Smith. (Count A. de Kergorlay.) November 28th. (Complete.)

25,933. "Improvements in or appertaining to junction and disconnecting boxes for underground electric mains." R. H. Clark. November 29th.

25,937. "A novel or improved composition to be used as a coating for metallic surfaces for the prevention of corrosion, and if desired for electrically insulating such surfaces." T. M. Hickman. November 29th.

25,950. "Coin-collecting device and system for telephone exchanges." H. D. Stroud. November 29th. (Complete.)

25,972. "Improvements in and connected with the protection of conductors and insulation of flexible cords for electrical apparatus." S. S. Galsworthy. November 29th. (Complete.)

25,979. "Improvements in electro-medical appliances." P. Wenigman. November 29th. (Complete.)

25,985. "Improvements in means for automatically winding clocks and the like with the aid of electricity." G. Hartmann November 29th.

26,034. "Improvements in telephonic intercommunication." J. Young. November 30th.

26,043. "Improvements in submarine telegraphy." I. Kitsee. November 30th. (Complete.)

26,063. "Electric current generating and motive-power machine." W. S. Frost. November 30th.

26,082. "Improvements in dynamo construction." H. Leitner and R. N. Lucas. November 30th.

26,092. "Improvements in or relating to receiver switches for telephone instruments." I. B. Birnbaum and F. G. Bell. November 30th.

26,094. "A device for use in testing electric ignition arrangements of internal combustion engines." W. P. Burke. November 30th.

26,096. "Improvements in controlling systems for electric motors." A. C. Eastwood. (Date applied for under Patents Act, 1901, March 21st, 1904, being date of application in United States.) November 30th. (Complete.)

26,097. "Improvements in magnetic clutches." A. C. Eastwood. (Date applied for under Patents Act, 1901, April 1st, 1904, being date of application in United States.) November 30th. (Complete.)

26,098. "Improvements in electric current-controlling systems." A. C. Eastwood. (Date applied for under Patents Act, 1901, June 4th, 1904, being date of application in United States.) November 30th. (Complete.)

26,099. "Improvements in motor-controlling systems." A. C. Eastwood. (Date applied for under Patents Act, 1901, June 10th, 1904, being date of application in United States.) November 30th. (Complete.)

26,124. "Electrical release movement." C. Vincent. December 1st.

26,157. "Improvements in and relating to electric arc lamps." F. Nusch. (A. Cotis, France.) December 1st. (Complete.)

26,161. "Improvements in or relating to electrical circuit-breakers." W. S. Toplis. December 1st.

26,169. "Improvements in thermal cut-outs." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,170. "Improvements in electric switches or cut-outs." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,171. "Improvements in armature windings for dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,172. "Improvements in electric switches and the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,174. "Improvements in and relating to electric transformers." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,175. "Improvements in electric transformers." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,176. "Improvements in and relating to electric transformers." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 1st.

26,194. "Improvements in dynamo-electric generators and motors." L. Torda. December 1st.

26,220. "Improvements relating to troughs or conduits for underground electric mains or cables and for similar purposes." J. Wilkinson. December 2nd.

26,260. "Improvements in electric arc lamps." J. B. Sipe. December 2nd. (Complete.)

26,269. "Improvements in coils for electro-magnets, solenoids and the like." J. B. Sipe. December 2nd. (Complete.)

26,282. "Improvements in switch installations for telephone exchanges and in switches therefor." Siemens Bros. & Co., Ltd. (Siemens & Halske, Akt. Ges., Germany.) December 2nd. (Complete.)

26,283. "Improvements in electric meters." O. Imray. (Société pour l'Exploitation de Compteurs Electriques, Rittener & Co., Switzerland.) December 2nd.

26,285. "Improvements in rotary-field electricity meters." C. D. Abel. (Siemens & Halske, Akt. Ges., Germany.) December 2nd. (Complete.)

26,288. "Improvements relating to electrical apparatus for training and elevating heavy guns." Vickers, Sons & Maxim, Ltd., A. D. Williamson and C. L. Sumpter. December 2nd.

26,290. "Improvements in the control of alternating-current motors and in apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 2nd.

26,291. "Improvements in and relating to vapour electric apparatus." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 2nd.

26,293. "Improvements in and relating to dynamo-electric generators." Allgemeine Elektricitats-Ges. December 2nd. (Date applied for under Patents Act, 1901, December 3rd, 1903, being date of application in Germany.) (Complete.)

26,294. "Improvements in electric brakes. The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 2nd.

26,295. "Improvements in electric control systems." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) December 2nd.

26,327. "Improvements in electric switches." T. H. Large. December 3rd.

26,331. "A guard for electric cars and such like for the saving of life." F. Darnton. December 3rd.

26,365. "An improved hygienic cover or pad for the mouth or ear pieces of telephone speaking tubes and the like." L. Huttenbach. December 3rd.

26,367. "An improved system of wireless telegraphy." W. F. Thompson. Ges. für Drahtlose Telegraphie, Germany.) December 3rd. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1903.

"Frog" or Plate for Making Connection Between the Ends of Line Wires at Junctions or Cross-Overs or any Place Where the Line is not Continuous in Conductors Used in Overhead Wiring for Electric Tramcars and the like Vehicles. L. C. Perkins. 25,305. November 20th.

Process and Apparatus for Producing a Shifting of Phase of 90° in Alternating Current Meters. E. Moick. 25,567. November 23rd.

Electric Arc Lamps. E. A. Carolan. (The General Electric Co., United States.) 12,301. May 29th.

Electric Circuit Controllers. E. A. Carolan. (The General Electric Co., United States.) 12,310. May 29 h.

Electric Steering Gear. E. A. Carolan. (The General Electric Co., United States.) 12,311. May 29th.

Manufacture of Materials Suitable for Insulating and Other Purposes. E. A. Carolan. (The General Electric Co., United States.) 12,312. May 29th.

Electric Meters. E. A. Carolan. (The General Electric Co., United States.) 12,313. May 29th.

Electric Motor-Control Systems and Switches Therefor. E. A. Carolan. (The General Electric Co., United States.) 12,314. May 29th.

Electric Motor-Control Systems. E. A. Carolan. (The General Electric Co., United States.) 12,315. May 29th.

Electric Heaters. E. A. Carolan. (The General Electric Co., United States.) 12,838. June 8th.

Controllers for Electric Motors. E. A. Carolan. (The General Electric Co., United States.) 12,839. June 8th.

Case for Electric Light Fuse Boards and Switches. J. Bolton. 12,907. June 9 h.

Enclosed Electric Arc Lamps. T. Hamilton-Adams. 13,226. June 12th.

Electric Alarm and Controlling Apparatus. J. Werner and J. Olsen. 13,279. June 13th.

Electric Selecting or Selecting and Signalling Systems for Communicating Between a Central, or Main Station and Various Other Places. 13,674. June 18th.

Method for Operating Signals on Electric Railways. S. M. Young. 13,746. June 19th.

Rubber Prices.—The India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd. announces that as a further important advance in prices in crude rubber has taken place, it is compelled to raise the quotations for its manufactures in proportion, the advance to take effect from December 12th.